Deadline for Submission of Bids:
July 21, 2011 at 2:00 P.M. (PST)
CSU Monterey Bay
Tanimura & Antle Family Memorial Library
Third Floor Build Out

PROJECT MANUAL

100% Construction Documents Set
March 26, 2012

500 Treat Avenue, #201
San Francisco, CA 94110
CERTIFICATION

Name of Project: CSUMB Tanimura & Antle Family Memorial Library – Third Floor Build Out

Bidding Documents Prepared By:

EHDD Architecture

500 Treat Avenue, Suite 201
San Francisco, California 94110

Typed Name: Thurston S. Shell
Title: Principal
Certification: C26397

(Affix professional registration stamp of the person named above with signature and expiration date or provide certificate number and signature if no stamp available.)
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1.1 Description of work

A. Commissioning is a designed quality-assurance process for achieving, verifying and documenting that the performance of facilities, systems and assemblies meet the owner’s documented objectives and criteria. The design team, contractor and subcontractors provide the quality control for the design, the installation and the startup of the building systems. The commissioning process provides review and quantitative functional testing in order to formally observe and document that the quality control efforts of the designers and contractors are successfully completed.

B. Commissioning includes the completion of a formal commissioning process on the equipment and systems within the Commissioning Scope of Work, as specified within Section 01810. Commissioning is performed by the Commissioning Team under the leadership of the Commissioning Authority (CxA). The entire Commissioning Team is responsible for performing the process and achieving successful commissioning results. The Commissioning Team is defined in the Definition of Terms portion of this section of the specifications. The CxA is from a totally independent firm under contract directly with the Owner, and is not contractually or financially associated with the Design Team or any Contractor performing work on this project. The Commissioning Authority is EnerNOC, Inc. (925-521-9600).

C. Commissioning Standards: The commissioning process shall be in accordance with:
   1. All sections of the Contract Documents
   2. The Building Commissioning Association’s (BCA) “Essential Attributes of Building Commissioning (1999)”
   3. ASHRAE Guideline 0-2005: The Commissioning Process

D. Contractors’ Responsibility: The Contractor is responsible for completion of the specified commissioning work. The contractors’ responsibilities include:
   1. The General Contractor shall provide a Commissioning Coordinator (CC), as defined in the Definition of Terms portion of this section of the specifications. The General Contractor’s Commissioning Coordinator is responsible for managing the commissioning work specified for the contractors.
   2. The Contractor shall be responsible for providing material, equipment and labor to participate in the specified commissioning process. The Contractor will assure the participation and co-operation of sub-contractors under their jurisdiction, as required to complete the commissioning process.
   3. The Contractor will support the commissioning process by integrating it into the construction process and schedule.

E. Support of Materials, Equipment and Systems Suppliers: Suppliers of major equipment and systems within the Commissioning Scope of Work (specified elsewhere in Section 01810) shall support the commissioning process. Minimum support shall consist of the following:
   1. Submit the manufacturer’s installation & startup manuals as a part of the initial equipment submittal in accordance with the equipment specifications.
   2. Submit the manufacturer’s operating and maintenance manuals as a part of the initial equipment submittal in accordance with the equipment specifications.
   3. Assist in developing the final functional test procedures as specified in Sections 15995 and 16995 and related sections.
   4. Provide authorized startup technician to perform functional performance testing as specified in Sections 15995 and 16995 and related sections.
1.2 Related sections

A. SECTION 15995 COMMISSIONING OF HVAC AND BMS
B. SECTION 16995 COMMISSIONING OF LIGHTING CONTROL SYSTEMS
C. All project specifications related to the “Systems Within The Commissioning Scope Of Work”

1.3 Systems within the commissioning scope of work

A. Heating, Ventilation and Air Conditioning (HVAC) Systems
   1. Air Handling Units
   2. Fan Coils
   3. Ductwork Systems
   4. Hydronic Piping Systems
   5. Automatic Temperature Controls
   6. Carbon Dioxide (CO₂) Sensors
   7. Testing, Adjusting and Balancing Air Handling Systems

B. Electrical Equipment Systems
   1. Power Distribution System
   2. Lighting/Daylighting Control Systems

1.4 Submittals

Provide the following submittals in accordance with the general submittal requirements specified elsewhere in Division 1:

A. Contractor's Systems Readiness Plan as specified in Part 3 of this Section.
B. Start-up procedures as required in the specifications for systems and equipment within the commissioning scope of work. This is required for acceptance of initial equipment submittal
C. Equipment Operation and Maintenance manuals as required in the specifications for systems and equipment within the commissioning scope of work. This is required for acceptance of initial equipment submittal
D. Contractors’ review of Initial FPTs.

1.5 Definition of terms

A. Acceptance Criteria: Acceptance of the systems is based on the contractor being able to demonstrate that the systems and their components function in accordance with the commissioning acceptance criteria.
   1. Installation and static testing acceptance criteria: The acceptance criteria for installation and static testing are the materials and methods requirements specified in Divisions 15 and 16.
   2. Functional testing acceptance criteria: The acceptance criteria for functional performance tests are described within the procedures. The functional performance test procedures include descriptions of system’s and component’s responses that are to be verified; these are the functional testing acceptance criteria. The functional testing acceptance criteria are based on the project documents and the basis of design.

B. Back-Checking: Back-Checking is the process of verifying that commissioning related issues have been resolved by the responsible party. The back-checking process takes place once the Contractor has provided written notification that an issue or issues in the Commissioning Issues Log have been resolved at which time the CxA verifies the issue’s resolution.
C. Commissioning Plan: This is a detailed document prepared and maintained by the Commissioning Authority CxA that describes the entire commissioning process.

D. Contractor's Start-up and Test Forms: Based primarily on the manufacturer's detailed installation, startup and checkout sheets, these are the various checks and tests performed on a piece of equipment or system just before or after preparing the equipment and system for initial operation. They are typically performed to confirm that equipment and individual components are working properly, such as electrical spot measurements on motors, spot flow measurements, pressure testing, pipe flush-out and cleaning, control point-to-point checks, sensor calibration, actuator testing, etc., and include such things as mechanical system test and balance (TAB). Contractor's Start-up and Test Forms are provided with the System Readiness Checklist (SRC) forms as part of the Systems Readiness Manual.

E. Contractor's System Readiness Checklist: These checklists are provided by the CxA and include equipment installation and start-up items specified to be performed and verified by the Contractor. These checklists shall be compiled by the Contractor along with associated start-up forms to create the Contractor's System Readiness Plan, and completed during installation and returned to the CxA as components of the Contractor's System Readiness Manual prior to the final CxA installation verification and functional performance testing process.

F. Contractor's System Readiness Plan: This document is compiled by the Contractor and includes, for each system within the commissioning scope of work, the System Readiness Checklists provided by the CxA, as well as associated Contractor's Start-up and Test Forms, defined in this section. The Contractor's System Readiness Plan shall be submitted to the CxA for review and approval prior to installation of the systems.

G. Contractor's System Readiness Manual: This document includes, for each system within the commissioning scope of work, completed and signed versions of each form submitted in the Contractor's System Readiness Plan. This document shall be completed by the Contractor and submitted to the CxA prior to the final installation verification and functional performance testing process. By submitting these completed forms, the Contractor signals that the relevant systems are installed, operational, and will meet functional testing acceptance criteria.

H. Commissioning Authority (CxA): The CxA is the owner's commissioning consultant and the leader of the commissioning Team. The CxA oversees the commissioning process and advises the owner on commissioning issues, emphasizing the long-term performance and maintainability of the systems included in the commissioning scope of work. The CxA is required to advise the owner of issues involving the design, construction, testing, adjusting and balancing, or other issues that would compromise the ability of the facility to meet the needs of the owner. The CxA is authorized to recommend to the owner the acceptance, modification, or rejection of all materials, procedures, schedules, tests, reports, or other required commissioning submittals. The CxA is not authorized to change existing contract documents, schedules, costs, or scope of work for any of the parties involved (architect or contractor).

I. Commissioning Issues Log: The document, which shall be maintained by the CxA, tracks the status of all issues raised during the commissioning process. The Issues Log includes the description of all issues discovered through the commissioning process. The list also includes the current issues status, assignment to the responsible party and the date of final resolution as confirmed by the CxA. Items listed may include issues where design, products, execution or performance does not appear to satisfy the Project Contract Documents and/or the design intent. The resolution of issues identified on this list may be the responsibility of the Contractor, design team, or the owner.

J. The Commissioning Team: The commissioning process is performed by the Commissioning Team, which consists of the Owner/Primary Owner's Representative, Commissioning Authority, the General Contractor, Commissioning Coordinator, the Design Team, all subcontractors performing work on the equipment and systems within the commissioning scope of work, and all materials and equipment suppliers supplying equipment and systems within the commissioning scope of work. The commissioning team is led by the Commissioning Authority. The Commissioning Coordinator is the on-site manager of the commissioning process for the General Contractor.

K. CxA Final Installation Verification Process: This process includes the on-site review of related system components for conformance to the Project Documents. The CxA will conduct this review and verify system readiness for final functional testing procedures upon receipt of the Contractor completed Contractor's System Readiness Manual. The CxA shall document issues identified during this process and assign them to the appropriate party for resolution.
L. Final Commissioning Report: The Final Commissioning Report contains a summary description of the commissioning process as it occurred during the project, and contains the final versions of all commissioning documentation. The Final Commissioning Report shall be prepared by the Commissioning Authority.

M. Functional Performance Testing Process: This process verifies that the systems within the commissioning scope function in accordance with the project documents, the owner's design intent, and the A/E's basis of design. The process includes the documented testing of the systems under actual and simulated operating conditions. Functional Performance Test (FPT) procedures are detailed instructions that allow experienced system technicians to perform the FPTs with repeatable results. The repeatability of the procedures and results validate the tests. Final performance testing of systems will begin only after the Contractor certifies that the installation of such systems is100% complete and ready for functional testing, and the CxA has completed the subsequent installation verification process for the systems to be tested.

N. General Contractor (GC): The Contractor directly contracted to the owner with overall responsibility for the project, and all commissioning activities described. The Contractor is responsible for all work within its contract scope, including that of the Installation Contractors.

O. General Contractor's Commissioning Coordinator (CC): The General Contractor shall provide a Commissioning Coordinator. The CxA, the owner's representative, and the CC comprise a commissioning management team. While the CxA leads the overall commissioning process, the CC is responsible for managing contractors in their day to day performance of the specified commissioning work. The CC is an employee of the General Contractor who is regularly and frequently on site. Qualifications for the Commissioning Coordinator include experience and excellent abilities to schedule, coordinate, and manage mechanical and electrical subcontractors. The following tasks are some of the critical items included in the CC's scope of work:
1. Integrating the specified commissioning activities into an overall construction schedule, updating the schedule, and providing two-week look-ahead schedules showing the upcoming commissioning related activities.
2. Providing all commissioning submittals to the CxA.
3. Coordinating owner training, and ensuring that training is provided in accordance with the commissioning specifications.
4. Ensuring that subcontractor and supplier review of the CxA provided FPT procedures and forms are completed and submitted in accordance with the specifications. This includes providing written comments regarding issues from all required FPT participants pertaining to safety, equipment protection and warranty, and appropriateness of the procedure for the systems as provided, and providing written comments, even if no exception is taken, for every FPT.
5. Coordinating development and submittal of specified flushing, cleaning and start-up procedures; and ensuring that these procedures are completed and documentation is submitted.
6. Providing test reports and progress reports in accordance with the commissioning specifications.
7. Managing the contractors' participation in the FPT process as specified in the commissioning specifications.
8. Managing the contractors' participation in resolution of issues identified during commissioning.
9. Ensuring that subcontractors perform preliminary testing to verify readiness for final FPT demonstrations; submitting documented verification that systems will pass FPTs with acceptable results as documented in the FPTs; and Coordinating the FPT demonstrations to Owner and CxA.
10. Coordinating repeat FPTs that fail due to contract deficiencies until acceptable results are achieved, and managing the reimbursement of the Owners costs for repeated tests in accordance with the specifications.

P. Initial Commissioning Coordination Meeting: This meeting is intended to present the Commissioning Plan to the commissioning team, which describes the commissioning process along with each party's role and responsibilities within the process; is typically scheduled to occur after bid award and prior to installation of commissioned systems.

Q. Percent Sampling: Inspecting or testing only a fraction of the total number of identical or near-identical pieces of equipment such as VAV boxes.

R. Performance Period: The performance period is a set length of time designated to demonstrate proper facility operation prior to acceptance. The performance period commences after successful completion of other functional testing. Performance data is typically collected via DDC system trend logging or data logging. Evaluation typically includes zone temperature stability, optimum start/stop, warm-up period and other related functions. As part of this process, the
contractor will be required to set up and provide trends of control system parameters per the direction of the CxA. The performance period trending logs shall be specified in the Functional Performance Test Procedures.

S. Primary Owner’s Representative: Has contractual authority to make decisions and change orders on the project in an effort to protect the best interests of the owner.

T. Project Contract Documents: As defined elsewhere in Division 1.

U. Seasonal or Deferred Testing: This testing is completed during conditions that do not occur during the initial functional testing period; for example during design or seasonal transition temperatures. Seasonal or Deferred FPTs are a limited sub-set of the original tests and are designed to evaluate capacity and systems’ interaction.

V. TAB: Testing, Adjusting, and Balancing or Test and Balance

W. Trending: Monitoring using the Building Automation Systems (BAS) to aid in functional testing and verify system operation and performance under actual operating conditions.

X. Warranty Issues: Operational and outstanding issues and deficiencies identified during the Warranty Period.

Y. Warranty Period: Warranty Period for the entire project, including components. Refer to General Conditions, Warranty, Guaranty, and Inspection of Work, for Warranty, Extended Guarantees, and Correction Period provisions

1.6 Construction phase commissioning process overview

A. After the bid award and acceptance of mechanical and electrical submittals, the Commissioning Authority will conduct an initial commissioning kick-off meeting with the Contractors, Owner’s Representative and the Design Team. The CxA will present the preliminary commissioning plan, discuss the commissioning process in detail and identify specific commissioning related responsibilities. Milestones shall be discussed, including contractor start-up and testing forms, preliminary O&M manuals, training agendas and other approved submittals needed to complete the plan. The final Cx plan will be developed after the CxA receives all submittals from the contractor and they have been approved by the design team.

B. The CxA will develop the System Readiness Checklist (SRC) forms for each system within the commissioning scope of work. These forms summarize specific aspects of the installation of each system that the Contractor must verify prior to conducting Functional Performance Testing. The SRC forms shall be submitted to the GC and Trade Contractors for review and comments, and subsequently compiled into the System Readiness Plan.

C. As part of the commissioning submittals, the Contractor shall submit a System Readiness Plan to the CxA. This document is typically a binder organized into sections with one section per system, each of which includes the System Readiness Checklists (SRCs) for that system, followed by Manufacturer- or Installation Contractor-provided installation checklists, detailed startup procedures, blank Test and Balance forms, and other project specific test forms. The CxA will review the System Readiness Plan and document any missing or erroneous forms. After the contractor provides the correct forms, the CxA will provide final approval and acceptance of the System Readiness Plan for use by the Contractor and/or Installation Contractors. Once approved, the System Readiness Plan is referred to as the System Readiness Manual.

D. The CxA will develop final equipment and system Functional Performance Test (FPT) procedures and forms with input from the Contractor, Owner, and A/E as specified in Part 3. These test procedures are submitted to the Contractor and Installation Contractors for review and comment

E. The CxA will update the Cx Plan with equipment specific documentation, checklists, and test forms.

F. Commissioning status meetings shall be scheduled to occur regularly during the construction and closeout phases to monitor progress and to help facilitate the commissioning process. Contractor representatives for commissioned systems
shall be required to attend these meetings. Meetings will generally be scheduled to occur with scheduled construction or management meetings.

G. The CxA shall perform periodic site visits during construction and, for each visit, identify potential issues in a site observation report. The Contractor shall review these site reports and resolve issues in accordance with the contract documents.

H. Pre-Functional Test Phase:
   1. The Contractors shall prepare the equipment and systems for startup in accordance with the Project Documents, industry standard guidelines, and the guidelines of the equipment and systems manufacturers. Startup shall be performed by the contractors and manufacturer’s startup technicians in accordance with the Project Documents, industry standard guidelines, and the guidelines of the equipment and systems manufacturers. The Contractor shall test the systems to verify that they perform in accordance with the Project Documents, including the Commissioning Functional Performance Test (FPT) Procedures.
   2. The CxA shall witness equipment start up and testing. The contractor shall notify the CxA in writing at least 10 working days in advance of the start-up and testing dates so that the CxA can schedule attendance. If the CxA is not notified in advance of a scheduled start-up or testing activity, the start-up or testing shall be rescheduled and repeated to the satisfaction of the CxA. When scheduled start-up activities are not executed because of lack of preparation or coordination by the Contractor, the Contractor will be subject to back-charges in accordance with the contract documents.
   3. Installing Contractors shall complete startup, testing, and checklists per the System Readiness Manual and submit to the CxA.
   4. Upon receipt of the completed System Readiness Manual forms, CxA will perform an Installation Verification by providing various inspections and back-checks of the completed System Readiness Manual forms. Issues noted during this process will be documented by the CxA in the Commissioning Issues Log.
   5. Upon acceptance of the System Readiness Manual, which includes the draft TAB report, functional performance testing shall be scheduled. Functional performance testing shall not commence until all critical issues identified during the Installation Verification process are resolved.

I. The FPTs are executed by the Installation Contractors under direction of the CxC, and witnessed by the CxA. The FPTs may be achieved by any combination of manual testing and analysis of performance trends monitored via the BAS system trending capabilities.

J. Issues noted during the functional performance tests will be documented by the CxA. When easily corrected, issues will be resolved at the time of discovery. The appropriate contractor will resolve all other issues at a later time. Issues will be tracked by issue number, date identified, responsible party, resolution status and most recent activity date. The contractor shall be responsible for reporting, in writing, to the CxA when issues have been resolved so that the CxA can verify the resolution.

K. The construction phase commissioning process will be complete when all noted issues have been corrected, proved to comply with the Project Documents or otherwise resolved to the satisfaction of the Owner.

1.7 Closeout phase commissioning process overview

A. Closeout contractor responsibilities include completion and submission of the Project Closeout Checklist for commissioned systems. Project closeout requirements and a draft checklist are included in this section.

B. Training on related systems and equipment operation and maintenance shall be scheduled after commissioning is satisfactorily completed, O&M manuals have been accepted and delivered to the owner, and systems are verified to be complete and functional. Each Contractor is responsible to provide a topical outline of all subjects to be covered in the training session(s), the expected length of time for the training sessions, and a brief resume listing the qualifications of the proposed training presenters. Training will be coordinated with the Owner.
C. Upon request, the Contractor is responsible for providing the CxA with copies of all balancing reports, as-built drawings and O&M manuals relevant to the systems commissioned. The CxA will review this material for compliance with Project Documents and will note and report all issues for resolution by the responsible party.

D. Upon completion of all commissioning activities, the CxA will prepare and submit to the owner the Final Commissioning Report detailing the commissioning process and all commissioning activities that were conducted during the process. The Commissioning Report will contain final versions of all documents developed during the commissioning process, including the final Commissioning Plan, completed System Readiness Manual, Functional Performance Testing documentation, and the final Commissioning Issues Log.

1.8 Back-charging

A. The Contractor is responsible for scheduling and coordinating commissioning activities. The Contractor shall reimburse the owner for the cost of commissioning activities that must be repeated because of a lack of preparation or coordination by the Contractor. Reimbursable costs include CxA fees for services billed at the CxA’s standard hourly rate of $190.00/hour, mileage billed at the current IRS rate, and the cost of any rented test equipment. Activities subject to back-charging include:

1. Repeated back-checking: Commissioning issues are documented in the Commissioning Issues Log. The Contractor shall submit a brief written statement describing when and how each issue has been resolved, which shall be added to the Issues Log maintained by the CxA. The CxA shall back-check these issues on a one-time-per-issue basis to verify they have been resolved. If the back-checked issues that have not been resolved as reported, the associated cost of the unsuccessful back-check shall be subject to back-charging.

2. Repeated installation verification: After the Contractor has submitted the completed System Readiness Checklists the CxA will perform final installation verifications on selected systems. Discrepancies discovered will be reported in the Commissioning Issues Log. Back-checking the correction of these discrepancies shall be subject to back-charging.

3. Repeated witnessing of FPT demonstrations: As specified in this section, the Contractor demonstrates the functional performance tests after they have verified that performing the FPTs will yield the documented acceptable results. The cost of witnessing demonstrations that do not demonstrate specified acceptance criteria shall be subject to back-charging.

2. PRODUCTS

2.1 Contractor systems readiness checklists

A. The Contractor shall maintain and complete copies of the Contractor’s System Readiness Checklist forms, which will be provided by the CxA. Initial forms are provided in the project specifications; however, working drafts will be created based on actual submittal data and contractor reviews. Checklist forms and supporting documents shall be signed by the Contractor and submitted to the CxA upon completion.

B. Completion of these items shall not release the Contractor from their responsibility to complete other specified requirements of the Project Contract Documents.

2.2 Startup procedures and forms

A. Contractor and/or Manufacturer startup procedures and checklists for equipment within the commissioning scope of work shall be submitted for review as a part of the equipment submittal. Minimum startup procedures are specified in the specifications for systems and equipment within the commissioning scope of work. Procedures shall also include all installation and start-up procedures and checklists that are provided by the equipment or system manufacturer. The accepted startup documentation shall be completed by the Contractor and submitted to the CxA for review and inclusion within the Final Commissioning Report.
2.3 Test instrumentation

A. The contractor shall provide the commissioning test equipment.

B. The test equipment shall be provided in sufficient quantities to execute functional testing in an expedient fashion.

C. The test equipment shall be suitable for testing and calibration with accuracy and tolerances necessary to demonstrate that system performance is in accordance with the basis of design.

D. Equipment used for functional testing sensors and gauges shall be certified to an accuracy of 10% of the smallest tolerance to be measured. For example, if a temperature gage is required to be ± 2 degrees F, the calibration device must have a minimum accuracy of ± 0.2 degrees F.

E. Instrumentation used for functional testing system performance must have a minimum repeatability and accuracy of ± 1.0% of the acceptance criteria being measured. For example: if a supply temperature of 50 degrees F is being verified, the repeatability and accuracy of the test instrument must be at least ± 0.5 degrees F.

F. The test equipment shall have calibration certification per equipment manufacturer's interval level or within one year if not specified.

2.4 Project close-out checklist

A. The Contractor shall complete and sign the Commissioning Project Closeout Checklist to indicate completion of Contractor's specified responsibilities regarding: arrangements for post-construction testing, spare parts for owner, final O&M manuals, as-built documents, O&M training, performance testing, indoor air quality testing and any other requirements that occur just prior to owner acceptance of the project. Initial forms are provided in the project specifications however, working drafts will be created based on actual submittal data and contractor reviews.

3. EXECUTION

3.1 Documentation

A. All checklists, start-up documentation, test forms and other commissioning related documentation required by contract shall be neatly completed and submitted to the CxA in a clear and easily readable condition.

B. All required checklists, start-up documentation, test forms and other commissioning related documentation shall be submitted to the CxA in accordance with the commissioning and construction schedule.

C. When the Contractor is unable to comply with an item as listed on the checklist or form, the Contractor shall immediately notify the CxA in writing as to the reason(s) for non-compliance.

3.2 Commissioning meetings:

A. The CxA will conduct a commissioning kick-off meeting, usually within 60 days of the commencement of construction. All team members involved in the commissioning process shall attend the kick-off meeting.

B. Other meetings may be required for direct coordination and prompt resolution of commissioning issues. The CC coordinates these meetings; and the CxA chairs and provides notes. Commissioning coordination meetings with the CxA shall be held on an as needed basis. The CC, the Owner/Owner’s Representative, CxA, and all subcontractors listed as members of the Commissioning Team shall attend these meetings. The attendance of other commissioning team...
members, such as Design Team and key equipment suppliers, may be required if necessary to efficiently address the meeting’s agenda.

3.3 Commissioning issues log

A. Issues identified during the commissioning process, including site observations, prefunctional testing verification and functional testing, will be logged in the commissioning issues log. The CxA will maintain the master log. For each issue, the CxA will make a recommendation regarding who they believe is in the best position to provide the resolution. It is the GC’s responsibility, however, to manage issue resolution, including the determination of how the issue will be resolved and who will do the work.

B. Each issue in the list will be classified with a “status” of either “resolved”, “unresolved” or “resolved-unverified”. Resolved issues are closed – having either been addressed by the contractor and verified as corrected by the CxA, or accepted by the owner. Resolved–unverified issues have been reported as resolved by the contractor, but are not yet verified by the CxA as resolved. Unresolved issues have not been reported as addressed by the contractor. Updated unresolved issues lists will be distributed to team in MS Word/Excel format.

C. Material and method issues discovered during commissioning, but that pertain to AE construction review will be transferred to the Design Team for tracking through resolution. When the design team reports the issue resolved, the CxA will classify the issue as Resolved, without back-checking.

D. When a commissioning issue is resolved, the Contractor shall submit an updated list with a written response describing when and how the issue is resolved. The CxA or the AE shall then back-check the resolution of said issue. The CxA scope of work includes one back-check of issues that the Contractor reports as resolved. BACK-CHARGING applies to back-checking required due to lack of preparation by contractor.

3.4 Pre-functional testing verification

A. Contractor’s Systems Readiness & Startup Activities: In preparation for the system readiness and startup, the contractor performs work in accordance with the contract bid documents, such as flushing and pressure testing piping systems, TAB, startup and contractor QC testing. The CC coordinates the subcontractors to verify and document that:

1. Piping and duct systems have been cleaned, flushed and tested in accordance with the contract documents.
2. Equipment is installed and placed into operation in accordance with the manufacturers’ requirements and contract documents.
3. The contractor shall perform equipment start-up per the accepted start-up plan and start-up forms included in the System Readiness Plan. The contractor shall correct issues as they are discovered and shall submit the documentation of successfully completed start-up activities to the CxA.
4. Equipment is accessible for maintenance, operation and testing.
5. All necessary instrumentation and flow control devices are provided, and sensors are properly located.
6. Equipment startup is performed in accordance with the contract documents, the equipment manufacture’s recommendations and good industry practices.
7. TAB is provided in accordance with the contract documents.

B. CxA Scope of Work: The CxA’s scope of work for pertaining to these activities shall consist of the following. The CC shall coordinate with the contractors and suppliers accordingly. The CxA shall receive a minimum of 10 working days advanced notice for any activity to be witnessed:

1. Review the contractor’s startup, testing, and TAB plans. Review completed documentation and include them in the final commissioning report.
2. For piping systems, review the contractors’ pressure testing and flushing plans for compliance with the specifications. Review completed documentation and include it in the final commissioning report.
3. Witness the TAB contractor’s demonstration of 10% of TAB measurements and settings.
4. For startup of major equipment:
   a. The CxA shall review the Contractor/supplier’s startup and test plan.
b. The CxA shall meet with the startup tech at the time of startup to discuss the startup plan.

c. The CxA shall be available via phone to answer questions during the startup period.

d. The CxA shall meet with the startup tech at the end of startup period to review and discuss the reports.

e. The startup tech shall meet with the CxA any acceptance criteria included in the Pre-Functional Tests (PFTs).

f. Startup reports shall be included in the final commissioning report.

3.5 Systems readiness documentation

A. For each system within the commissioning scope of work, the CxA creates System Readiness Checklists for the Contractor, which document that the equipment has been installed and placed into operation in accordance with the project requirements and is ready for functional testing

B. The Contractor shall develop a System Readiness Plan, which shall include the following for each system within the commissioning scope of work:
   1. Systems Readiness Checklists – provided by CxA and to be completed by the Contractor.
   2. Startup and testing procedures and data forms, in accordance with the project specifications, for all equipment and systems within the commissioning scope of work.
   3. Blank Testing and Balancing forms and reports, where applicable.
   4. Piping and duct testing reports, where applicable, to be approved by the AE.
   5. Water treatment reports, where applicable, to be approved by the AE.
   6. See specifications Sections for any further requirements for specific systems.

C. Within 20 working days of Product Submittal approval, the Contractor shall submit the Systems Readiness Plan with blank forms for CxA review.

D. As the systems are installed and equipment is started up, the Contractor shall complete the forms provided in the Systems Readiness Plan. Once the forms are completed, this document shall be known as the Systems Readiness Manual. This document shall include, for each system within the commissioning scope of work:
   1. Completed Systems Readiness Checklists, signed by the installation contractor and the Contractor's Commissioning Coordinator.
   2. Completed startup and testing forms
   3. Completed Testing and Balancing forms and a draft TAB report, where applicable.

E. The Contractor shall submit the completed Systems Readiness Manual prior to functional performance testing. When it is necessary to begin functional performance testing on a system (or systems) before the readiness of other systems can be documented, it may be acceptable to provide preliminary submittals of the Systems Readiness Manual that have been completed only for the system(s) that are ready for testing.

F. The CxA shall review all completed System Readiness Checklists, startup forms, and supporting documentation from installation and start-up activities provided in the System Readiness Manual.

   The CxA randomly double-checks the contractor's forms.

   Acceptable results must be demonstrated for the entire sample. If the actual state of the system, equipment, or component is not consistent with the state documented in the readiness forms, the forms for all similar systems equipment or components will be double-checked. Whenever the double-checking results are not acceptable, the contractors shall make corrections and the PFTs shall be demonstrated again in accordance with the commissioning specifications. The cost of back-checking with unacceptable results and expanded sampling is not included in the Commissioning Authority’s scope of work. Back-charging applies to additional back-checking required due to lack of preparation by contractor.

G. Approval of completed System Readiness Manual by the CxA is required prior to Functional Performance Testing of equipment and system
3.6 Functional performance tests (FPTs)

A. Functional performance testing of commissioned systems shall begin after all critical issues discovered during the installation verification process have been corrected.

B. The procedure for developing and performing the FPTs shall be as follows.

1. The Contractor shall provide the equipment and commissioning submittals as specified in the project documents.
2. The Commissioning Authority shall draft the FPT procedures based on the contractor's submittals as approved by the AE. The draft procedures shall be submitted to the Commissioning Team for review.
3. Each contractor and equipment supplier that is specified as an FPT participant in the FPT Summary Tables shall participate in the development and performance of the associated FPTs. Each FPT participant shall provide written comments on the associated FPT procedures regarding each of the following issues:
   a. Verify that the procedures can be performed without compromising the safety of the participants.
   b. Verify that the procedures can be performed without compromising the warranties of equipment, components, and systems.
   c. Verify that the procedure is appropriate for the equipment, components, and systems as provided.
   d. At the contractor's option, make recommendations to incorporate the FPTs into the contractor's in-house startup and QC testing process.
4. The CxA shall complete the working drafts of the FPT procedures.
5. Subcontractors and suppliers shall provide the personnel, expertise and test equipment to operate and maintain the systems during testing.
6. The Contractor shall test all systems within the commissioning scope of work, using the FPT procedures until the acceptable results specified in the FPT procedure are verified and documented. If necessary to obtain acceptable results, the Contractor may consult with the CxA to acquire clarification and resolve issues. The CxA shall be available for on-site assistance of this nature.
7. The Contractor shall submit documentation that verifies that the acceptable results specified in the FPT procedures have been verified and that they are ready to demonstrate the FPTs with acceptable results. Acceptable documentation consist of completed FPT record forms which document acceptable FPT results, or indication on the Systems Readiness Checklists that the Contractor’s pre-functional testing has verified that functional performance testing of the equipment and associated system demonstrates the acceptable results.
8. After the CxA has accepted the Contractor's documentation of acceptable results, the FPT shall be conducted and demonstrated to the CxA. If acceptable results are not demonstrated for a FPT, the Contractor shall resolve the issue(s) and the demonstration shall be repeated.
9. The contractors shall verify and document acceptable FPT results for all equipment components and systems. The FPTs may be demonstrated for a sample of the systems that comply with all of the following criteria. This process is referred to in this document as "demonstration sampling."
   a. There shall be many of the systems with similar components that have identical sequences of operation which are implemented using identical control software programming.
   b. The components and systems to be included in the Demonstration Samples shall be chosen by the CxA at the time of demonstration.
   c. The sample size shall be in accordance with the Functional Performance Test (FPT) Demonstration Sampling Tables.
   d. Acceptable results must be demonstrated for the entire sample. If the FPT results are not acceptable due to a lack of preparation or coordination by the Contractor for any system or component sampled, the FPT shall be demonstrated for all of the systems and components for which it was written. Whenever the demonstrated results are not acceptable, the contractors shall make corrections and the FPT shall be demonstrated again. The cost of back-checking FPTs with unacceptable results is not included in the Commissioning Authority's scope of work. BACK-CHARGING applies to additional back-checking required due to lack of preparation by contractor.
10. The CC is responsible for scheduling and coordinating functional testing activities. The Contractor shall demonstrate the functional performance tests after they have verified that performing the FPTs will yield the documented acceptable results. The contractor is subject to back-charging, as specified herein, if acceptable results are not demonstrated because of work that should have been verified during pre-demonstration testing prior to the submittal of the Systems Readiness Manual. Acceptable results must be obtained during a single demonstration. No more than two delays of less than 15 minutes each are acceptable for each test.
C. In addition to conducting the functional tests developed by the CxA, the Contractor shall be required to complete all start-up and testing procedures as specified elsewhere in the Project Contract Documents.

D. Where the CxA requires BAS trending, the CxA will provide within a FPT form a points list that may include both hardware (inputs, outputs) and virtual/software points, and appropriate trending intervals.
   1. The Contractor and Installation Contractors shall provide trend data to the CxA in electronic format. As an owner approved alternative, the Contractor can provide the CxA remote access to the control system and provide training that will allow the CxA to directly download trend data.
   2. The CxA will analyze and review the trend data and associated system performance

3.7 Deficiencies and commissioning issues correction

A. During the Pre-functional Testing Phase all deficiencies and commissioning issues will be documented on the inspection and test forms in use and will additionally be documented by the CxA on a Commissioning Issues Log

B. Issues entered into the Commissioning Issues Log, shall be resolved by the contractor in a timely manner. The Contractor shall submit a brief written statement of when and how each issue has been resolved.

C. The CxA will record completion on the Commissioning Issues Log and the CC shall reschedule testing with the CxA and Installation Contractor. Testing shall be repeated until passing performance is achieved or the owner accepts the noted issue.

D. When there is a dispute regarding a Commissioning Issue, whether it is a question of validity or responsibility, additional parties may be brought into the discussion as appropriate. The CxA shall have the final interpretive authority and the owner will have the final approval authority.

E. The CxA may recommend solutions to deficiencies and commissioning issues. However, the burden of responsibility to solve, correct and perform required retests is with the Contractor, Installation Contractors and the Design Professional(s).

F. Retesting:
   1. For all Commissioning Issues identified during Functional Performance Testing, retesting is required to verify the resolution of the issue and to complete the FPT.
   2. The CxA will witness one re-test for each equipment or system. A minimum 48 hours notice is requested for scheduling any re-testing, though the CxA will work to accommodate a shorter timeframe if feasible.
   3. Any required retesting shall not be considered a justified reason for a claim of delay or for a time extension

3.8 Performance period

A. Functional performance testing shall include a performance period test plan, which includes measured variables and success criteria based on performance characteristics described in the Project Documents. The CxA will provide the Control System Contractor with a list of required trend log definitions to be implemented as a basis for reviewing performance during this period.

B. The Contractor will review the performance period test plan and set up the trend log definitions from the CxA. The trending shall be provided by the contractor in both a text and graphic format with related system parameters grouped together for easy comparison. If DDC system resident memory is limited or there are other issues with the trending requirements, the Contractor will notify the CxA and request the CxA redefine the test plan.
C. The performance period shall be as specified in the FPTs. If failures are encountered, the performance period shall be aborted. After corrections are made, the performance period shall be re-started at day one. Back-charging as specified herein shall apply.

3.9 Scheduling of functional performance test (fpt) demonstrations

A. The procedures for developing, performing and demonstrating the FPTs are specified in Sections 15995 and 16995.

B. Allow the following durations for FPT demonstration periods. These are preliminary estimates based on a single successful demonstration for each FPT procedure, with no delays. These estimates do not include the contractors pre-demonstration testing to verify that the systems will perform in accordance with the acceptance criteria.
   1. HVAC systems FPT demonstration period: On average 4-6 hours for each large air handler and 1-2 hours for the smaller unitary systems (Does not include trending)
   2. Lighting control FPT demonstration period: 5 working days

3.10 Systems acceptance

A. Equipment and systems shall not be accepted by the Owner until all commissioning activities are complete and the performance period standards have been met and the project closeout requirements have been met as listed in the next section.

3.11 Project closeout

A. Post construction contractor responsibilities include completion and submission of the Project Closeout Checklist for each commissioned system to the CxA, to verify completion of contractual obligations for the owner. Project closeout requirements, tracking sheet and checklists are included in Schedule 1 located at the end of this section.

B. Training on related systems and equipment operation and maintenance shall only be scheduled to commence after functional testing is satisfactorily completed, O&M manuals have been delivered and approved, and systems are verified to be 100% complete and functional. Each Contractor is responsible to provide a topical outline of all subjects to be covered in the training session(s), the expected length of time for the training sessions, and a brief resume listing the qualifications of the proposed training presenters. The CC is responsible for developing the training plan with input from the contractor and directing any videotaping efforts. The CC is responsible for coordinating training with the Owner and CxA and to verify execution of the training plan.

C. Upon request, the Contractor is responsible for providing the CxA with copies of all balancing reports, as-built drawings and O&M manuals relevant to the systems commissioned. The CxA will review this material for compliance with Project Documents and will note and report all issues for resolution by the responsible party.

D. Upon completion of all commissioning activities the CxA will prepare and submit to the owner the Final Commissioning Report detailing the commissioning process and all completed commissioning activities and recommending acceptance to the Owner. The CC will support this effort by coordinating the contractor provided documentation.
SCHEDULE 1 -

GENERAL CONTRACTOR’S COMMISSIONING CLOSEOUT CHECKLIST

INSTRUCTIONS:

Contractor’s Commissioning Coordinator shall verify completion of all items, sign and return the checklist to the Commissioning Authority as an indication of final completion with all installation criteria as specified in the Project Contract Documents.

PROJECT CLOSEOUT CHECKLIST:

  Training has been completed in compliance with specifications.

  O&M Manuals are complete and submitted.

  Warranties have been provided to Owner.

  Record drawings have been updated as-built.

  Required spares have been submitted to owner and receipt of materials signed.

  Contractor considers all specified close-out requirements to be complete.

PLEASE NOTE: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: __________________________ Date: ______________ Company: __________________________

END OF SECTION 01810
SECTION 06410
ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section describes the requirements for furnishing and installing architectural wood casework, including but not limited to the following:
   1. Custom plastic laminate faced cabinetwork and bookshelves.
   2. Plastic laminate countertops.

B. Related Sections:
   1. Construction waste management is specified in Section 01505.

1.02 SUBMITTALS

A. General: Comply with Division 1.

B. Samples: Specified plastic laminate colors for verification of initial selections.

C. Shop Drawings: Show details of fabrication and installation, dimensioned plans, elevations, and sections. Each set of shop drawings shall comply with Architectural Woodwork Standards (AWS) Section 1 – Submittals.

   1. Shop drawings shall bear the Woodwork Institute Certified Compliance Program Label on the first page. Photocopies of architectural drawings are not acceptable. Highlight any modifications to the Specifications or AWS requirements.

1.03 QUALITY ASSURANCE

A. Materials and fabrication of cabinetwork shall be in accordance with the standards of the Architectural Woodwork Standards (AWS) for the grades specified.

B. WI Certified Compliance Program (CCP):

   1. Before delivery to the Project site, provide a Woodwork Institute Certified Compliance Certificate indicating the items to be provided and certifying that they meet the requirements of the Architectural Woodwork Standards and the plans and specifications.

   2. Each elevation of casework and plastic laminate countertops shall bear the WI Certified Compliance Label indicating conformance to specified grade.

   3. Upon completion of installation, furnish a WI Certified Compliance Certificate for the installation.

   4. In the event of question as to compliance with the referenced standard of any item of work, the Architect may require independent inspection service of questioned items as specified in “Independent Inspection Service” of “WI Services and Quality Control Options” published by the WI.

1.04 ENVIRONMENTAL QUALITY ASSURANCE

A. Adhesives, sealants and sealant primers shall not exceed the VOC limits established in South Coast Air Quality Management District Rule 1168, effective date of July 1, 2005 and rule amendment date of January 7, 2005.

B. Do not use composite wood and agrifiber products that contain added urea-formaldehyde resin.

C. Laminating adhesives used to fabricate composite wood and agrifiber assemblies shall not contain added urea-formaldehyde resins.

D. Wood products shall originate in forests that are certified according to the rules of the Forest Stewardship Council.
(FSC). Approved vendors are available online at [www.fscus.org](http://www.fscus.org).

1. FSC-accredited certifying agencies include the following:
   a. Smart Wood Program ([www.smartwood.org](http://www.smartwood.org)).
   b. Scientific Certification Systems ([www.scscertified.com](http://www.scscertified.com)).
   c. SGS Qualifor ([www.qualifor.com](http://www.qualifor.com)).
   d. Soil Association ([www.soilassociation.org](http://www.soilassociation.org)).

2. Follow proper procedures to ensure that certified wood products are kept separate from non-certified materials and that auditing procedures as mandated by the certifier are complied with.

3. Submission of a Chain of Custody certificate without an invoice or submission of an invoice without a Chain of Custody certificate shall not constitute acceptable documentation.

4. Proper procedures shall be followed to ensure that certified wood products are kept separate from non-certified materials and that auditing procedures as mandated by the certifier are complied with.

### 1.05 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is completed, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Check actual dimensions of other construction by accurate field measurements before fabrication, and show recorded measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

   1. Verify locations of concealed framing, blocking, backing, reinforcements, and other items that support cabinetwork by accurate field measurements before being enclosed and record on shop drawings.

C. Verify that wall, ceiling and floor surfaces to receive casework are within acceptable tolerances.

### 1.06 COORDINATION

A. Cabinets shall be left in a well ventilated warehouse for a minimum of 72-hours prior to delivery to the Project site.

B. Cabinets shall be acclimated to the field conditions for a minimum of 72-hours prior to installation.

### 1.07 INDOOR AIR QUALITY

A. Do not use wood products containing urea formaldehyde glues inside the shell of the building.

B. When machining plastic products, protect surrounding areas from dust.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

A. Materials and fabrication are to meet the requirements of the Architectural Woodwork Standards for the grade(s) specified.

   1. If there is a conflict between the AWS and the drawings and/or specifications, the drawings and specifications shall govern.

#### 2.02 MATERIALS

A. High-Pressure Decorative Laminate (HPDL): Comply with Architectural Woodwork Standards (AWS) Section 4 and NEMA LD3.
1. Horizontal Surfaces: HGS, 0.048-inch nominal thickness.
2. Vertical Surfaces: VGS, 0.028-inch nominal thickness.
3. Horizontal Post-formed Surfaces: HGP, 0.039-inch nominal thickness.
4. Fire-Rated Surfaces: HGF, 0.048-inch nominal thickness.
5. Cabinet Liner: CLS, 0.020-inch nominal thickness.
6. Backer: BKL, 0.020-inch nominal thickness.
7. Manufacturer, Pattern, Sheen, Color:
   b. PL-02: Abet Laminati, Solid Colors, Bruno Vulcano, 897 SEI. Provide on countertops unless otherwise indicated.

B. Low-Pressure Decorative Laminate (LPDL): Comply with Architectural Woodwork Standards (AWS) Section 4 and NEMA LD3. LPDL shall consist of melamine, polyester or foil resin-impregnated paper thermally fused under pressure to an approved core and have a balance sheet.

C. Balance Sheet for Plastic Laminate Faced Casework: HPDL or overlay of a compatible thickness.

D. Hardboard: Manufactured of interfelted lignocellulosic fibers, consolidated under heat and pressure to a density of 31-pcf or greater, tempered grade, 1/4-inch-thick tempered, smooth both sides.

E. Backing for Plastic Laminate: One of the following, at Contractor's option.
   1. Medium Density Fiberboard:
      a. Dry Areas: Medite Corporation "Medite II" or approved equal (no known equal) medium density fiber board, 3/4-inch thick, 48-pcf density. Fiber board shall have a recycled content of 92-percent.
      b. Countertops with Sinks: Medite Corporation "Medex" or approved equal (no known equal) medium density fiber board, 3/4-inch thick, 48-pcf density. Fiber board shall have a recycled content of 92-percent.
      c. Medium density fiberboard shall contain no added urea formaldehyde resins.
   2. Plywood: Architectural Woodwork Standards (AWS) Grade B close grain hardwood veneer plywood, smooth, well sanded, thickness indicated. Provide exterior grade with waterproof glue at countertops with sinks. Plywood shall contain no added urea formaldehyde resins.
   3. Particleboard: One of the following at Contractor's option:
      a. Roseburg Forest Products "SkyBlend Particleboard" or approved equal complying with ANSI A208.1, Grade M-2. Particleboard shall contain 100-percent pre-consumer recycled wood fiber. Do not use at countertops with sinks.
      b. Straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density. Do not use at countertops with sinks.
      c. Particleboard shall contain no added urea formaldehyde resins.

F. Subframe Lumber: No. 1 grade Douglas Fir or plain sawn Yellow Poplar.

G. Adhesives: VOC-compliant contact, semi-rigid or rigid adhesives as recommended by laminated plastic manufacturer.

H. Hardware: Furnish and install as required to provide a complete casework installation.
1. Hinges: 120-degree opening, concealed hinge, passing 100,000-cycle test. Hinges shall be all-metal construction, meeting or exceeding the ANSI/BHMA Grade 1 performance and permanent set test requirements. Provide three hinges on doors over 48-inches high.

2. Door and Drawer Pulls: Hickory Hardware No. PW355-26D Wire Pull, 5/8-inch diameter x 4-inch center-to-center, satin chrome finish.

3. Door Locks: Corbin 0737, Olympus 1000DR or approved equal. Key as directed by the Owner.

4. Drawer Locks: Corbin 0738, Olympus 200DW or approved equal. Key as directed by the Owner.

5. Drawer Guides: Accuride, Blum, Grant, K&V or approved equal.
   b. General Purpose Drawers: Full extension, minimum 100-pound capacity.
   c. File Drawers: Full extension, minimum 150-pound capacity; 200-pound capacity at lateral file drawers wider than 30-inches.

6. Adjustable Shelf Standard: Grant 120, K&V 255 or approved equal.

7. Adjustable Shelf Clips: Grant 21Z, K&V 256 or approved equal.

2.03 FABRICATION

A. Fabricate products in accordance with the approved Shop Drawings and specified Architectural Woodwork Standards (AWS) Grade requirements. The architectural drawings indicate form and profile concept only. Fabrication and construction details shall comply with AWS unless otherwise specified.

B. Fabricate laminated plastic casework and bookshelves in accordance with Architectural Woodwork Standards (AWS) Section 10, Construction Type A – Frameless Construction; Interface Style 1 – Flush Overlay.

1. Grade: Custom except as otherwise specified.

2. Exposed exterior portions shall be covered with a HPDL as specified.

3. Exposed interior surfaces, except at doors and drawer fronts shall be covered with a HPDL matching exposed exterior surfaces.

4. Exposed interior surfaces of door and drawer fronts shall be covered with the same material, pattern, color and thickness as the door face.

5. Edge Banding: HPDL or PVC, minimum 0.02-inch thick, color-matched to the exposed face.

6. Semi-exposed surfaces of cabinet tops and bottoms, cabinet ends, fixed and adjustable shelves, cabinet back, shall be finished with a polyester laminate; exposed edges of semi-exposed surfaces shall be finished with extruded PVC or self-edged plastic laminate.

7. Door and Drawer Edge: Square edge with thin applied band.

8. Shelf Thickness: As specified in Architectural Woodwork Standards (AWS) for a uniform load of 50-lb./sq. ft.

9. Drawer Construction: Dowel or dovetail construction. Sides of 7 or 9 ply hardwood plywood with no voids. Bottoms of hardwood plywood of the same species and cut as the sides.

C. Laminated Plastic Countertops: Fabricate in accordance with Architectural Woodwork Standards (AWS) Section 11, Premium grade.

1. Countertop Splash Assembly: AWS Assembly 2, deck-mount back and end splashes.
2. Countertop Edges: Self-edged with plastic laminate or hardwood trim as indicated.

3. Back Splash: Horizontal square butt joints or integral cove as indicated.

4. Top of Back Splash: Square with self edge.

5. Back Splash Height: As indicated.

D. Make cuts required to accommodate the work of other Sections in the shop where possible. Review other drawings and work to determine extent of items to be mounted in cabinetwork. Notify the Architect of discrepancies.

E. Shop-fabricate cabinets and countertops in whole units or partial units practical for handling and transporting. Assemble partial units in place so that each complete unit becomes a unified whole visually and structurally. Fabricate fillers and scribe strips of same materials and finishes as adjacent units.

F. Make cuts for hardware and equipment neat and true. Install hardware and fit securely.

G. Adjust drawers, doors, and movable shelves to operate easily and smoothly without binding.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cabinetwork in accordance with Architectural Woodwork Standards (AWS) Premium Grade requirements.

B. Install products plumb and level.

C. Securely fasten cabinetwork to supporting substrate as indicated.

D. Anchor tops to base units and other supports as indicated. Seal space between backsplash and wall with sanitary sealant specified in Section 07920. Install with no more than 1/8-inch in 8'-0" sag, bow, or other variation from straight line.

E. Fit tight and scribe to walls, ceilings, and other surfaces so no open joints occur.

F. Remove and replace materials damaged beyond repair or stained beyond cleaning.

3.02 ADJUSTMENT, CLEANING, AND PROTECTION

A. Repair damaged and defective cabinetwork where possible to eliminate defects; where not possible to properly repair, replace.

B. Clean, lubricate and make final adjustments to hardware for proper operation.

C. Clean cabinetwork on exposed and semi-exposed surfaces. Touch-up shop-applied finishes to restore damaged or soiled areas.

D. Protect cabinetwork to ensure work will be without damage at time of Substantial Completion. Cover completed cabinetwork with 4-mil polyethylene film protective enclosure, applied in a manner to permit easy removal.
3.03 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with Section 01505.

B. Separate the following categories for salvage or re-use on the site:

1. Sheet materials larger than 2-sq. ft.
2. Solid wood trim longer than 16-inches and multiple offcuts of any size larger than 12-inches.

C. Separate the following for recycling. Material shall be placed in source-separated or comingled recycling bins.

1. Composite wood.
2. Clean dimensional lumber.

D. Separate the following categories for disposal and place in designated areas for hazardous materials:

1. Treated, stained, painted, or contaminated wood.

END OF SECTION
SECTION 07840
FIRESTOPPING

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing firestopping.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Joint sealants are specified in Section 07920.
   3. Non-structural metal framing is specified in Section 09110.
   4. Gypsum board is specified in Section 09250.
   5. Acoustic insulation is specified in Section 09810.
   6. Plumbing is specified in Division 15.
   7. Electrical is specified in Division 16.

1.02 SYSTEM PERFORMANCE REQUIREMENTS
A. General: Provide firestopping systems capable of closing or filling through-penetrations created by the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials, or by the deflection of sheet metal due to thermal expansion.
B. For firestopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.
C. For firestopping exposed to view, provide products when flame-spread values of less than 25 and smoke-developed values of less than 450, when tested in accordance with ASTM E84.

1.03 SUBMITTALS
A. General: Comply with Division 1.
B. Product Data: Manufacturer's descriptive, technical data and illustrations. Include manufacturer's installation instructions.
C. Certification:
   1. Manufacturer's certification that products comply with local regulations controlling use of volatile organic compounds (VOC's) and are nontoxic to building occupants.
   2. Manufacturer's certification that firestopping materials comply with ASTM E814 and UL 147.
D. UL Design Numbers: Furnish UL Design No. from the "Fire Resistance Directory - Volume II" for each required penetration type and configuration. Indicate which materials will be used in firestopping the penetration. Reference architectural, mechanical, plumbing and electrical drawings.
E. Furnish documentation indicating deflection and elongation capacity of all head of wall assemblies are equivalent in capacity to design assemblies.
1.04 QUALITY ASSURANCE

A. Firestopping materials and systems shall be listed and labeled in accordance with requirements of Underwriters Laboratories, Inc. (UL) Building Materials Directory.

B. Firestopping materials shall conform to California Building Code (CBC) for fire resistance standards and requirements for penetrations in walls, partitions, and floor/ceiling and floor/roof assemblies.

C. Firestopping materials shall comply with ASTM E814 and UL 1479.

D. Firestopping sealants shall comply with ASTM C719 and ASTM C920.

E. Form materials to remain in place in the completed work and sealant used for firestopping work shall be UL listed and labeled.

F. Firestopping materials shall be rated as required when tested in accordance with ASTM E119.

G. Firestopping materials shall be asbestos free and shall not incorporate nor require the use of hazardous solvents.

H. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surface.

I. Installer shall have a minimum of 5-years experience installing UL listed firestop systems in similar type construction.

1.05 ENVIRONMENTAL QUALITY ASSURANCE

A. Adhesives, sealants, and sealant primers shall not exceed the VOC limits established in South Coast Air Quality management District Rule 1168, effective date of July 1, 2005 and rule amendment date of January 7, 2005.

B. Firestopping materials shall have a minimum of 20-percent combined pre-consumer/post-consumer recycled content.

1.06 JOB CONDITIONS

A. Follow manufacturer's instructions for temperature, ventilation, and other conditions for mixing and installing foam seals.

B. Observe and follow manufacturer's precautions when using materials considered toxic and hazardous.

C. Maintain current copy of UL “Fire Resistance Directory” on Project site.

D. Installation of firestopping shall precede finishing of gypsum board.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1.

B. Deliver materials in the manufacturer's unopened containers and packages with manufacturer's name, labels, product identification, lot numbers, and mixing and installation instructions, as applicable.

C. Store materials in unopened containers and packages, and under conditions recommended by manufacturer.

D. Store and handle firestopping materials in accordance with manufacturer's Material Safety Data Sheets.

1.08 PROJECT CONDITIONS

A. Environmental Conditions: Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilation: Ventilate firestopping in accordance with manufacturers' instructions by natural means or forced air circulation.
1.09 SEQUENCING AND SCHEDULING
A. Perform work of this and other Sections in proper sequence to prevent damage to the firestopping materials and to ensure that their installation will occur prior to enclosing or concealing work.
B. Do not cover firestopping materials until they have been properly inspected and accepted by the authority having jurisdiction.

PART 2 - PRODUCTS
2.01 FIRESTOPPING, GENERAL
A. Compatibility: Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the penetrating items.
B. Accessories: Provide components of each firestopping system required to install fill materials. Use only components specified by firestopping manufacturer and which are approved by UL for the designated fire-resistance-rated system.
C. Manufacturers or systems not listed in UL “Fire Resistance Directory” but who can furnish certification of UL approval may be used in the work.

2.02 THROUGH-PENETRATION FIRESTOPPING MATERIALS
A. General: Listed manufacturers of through-penetration firestopping are intended as guidelines only; manufacturer and material type shall be as required by the UL Design No. for each penetration to receive firestopping.
C. Provide mortar, sealants and caulk, putty, wrap strips, pillows, bags, and other types required for UL Design No. for each penetration to receive firestopping.

2.03 MINERAL FIBER FIRESTOPPING MATERIALS
A. Material: Semirigid mineral fiber insulation, minimum 4-pcf density; USG Interiors “Thermafiber Safing”, Johns Manville “Insul-Shield”, Thermal Ceramics Inc. “Cerablanket F.S” or approved equal.
B. Support Clips: Manufacturer’s standard impaling clips or custom designed to suit installation conditions, fabricated from galvanized sheet steel.
C. Smoke Sealant: Thermafiber “Smoke Seal Compound”, “Firecode Compound” or “Fire Barrier”, Specified Technologies Inc. “SpecSeal AS200 Elastomeric Spray” or “SpecSeal Fast Track Spray”, 3M “FireDam 100 Spray” or as indicated in the applicable UL Design No. for required fire-rating.

2.04 FIRESTOPPING AT ELECTRICAL BOXES AND UTILITY OUTLETS
A. Utility penetrations in walls, ceilings, or floors requiring protected openings shall be firestopped and sealed with an approved material securely installed, capable of maintaining its integrity when subjected to test temperatures specified in ASTM E814.
B. Steel electrical outlet boxes on opposite sides of walls requiring protected openings shall be separated by a horizontal distance of 24-inches.
C. Steel electrical outlet boxes which occur in combination with outlet boxes of any size such that the aggregate area of unprotected outlet boxes exceeds 100-square inches in any 100-square feet of wall area shall be protected by an approved material or detail to decrease the aggregate area of unprotected utility boxes to less than 100-square inches in any 100-square feet of wall.
D. Steel electrical outlet boxes which exceed 16-square inches in area shall be protected by 3M "Moldable Putty Pads", Specified Technologies, Inc. "SpecSeal Series SSP Putty Pads" or approved equal.
E. Utility and electrical outlets or boxes shall be securely fastened to the stud or framing of the wall or ceiling.
assembly. The opening in the gypsum board shall be cut so that the clearance between the box and the gypsum board does not exceed 1/8-inch.

1. Fill the 1/8-inch gap with an approved fire-rated sealant.

2.05 FIRESTOPPING AT METAL DECK FLUTES

A. Steel Deck Insert: Fyre Sleeve Industries, Inc., “Q-Stop” or approved equal one-piece fire-retardant plug for steel deck flutes.


C. Mineral Wood: Minimum 4-pcf density.

2.06 MIXING

A. For those products requiring mixing prior to application, comply with manufacturer’s instructions.

2.07 ESCUTCHEONS

A. Provide brushed stainless steel escutcheon plates at pipes and conduit exposed to view. Size to suit penetration.

PART 3 - EXECUTION

3.01 INSPECTION

A. Inspect openings and voids to be sealed to determine if conditions are satisfactory for the proper installation of firestopping. Do not commence work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning: Clean out openings and joints immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer.

1. Remove foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.

2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping.

3. Remove laitance and form release agents from concrete.

B. Priming: Prime substrates where recommended by manufacturer using manufacturer’s recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking: Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of the work. Remove tape as soon as possible.

3.03 EXTENT OF FIRESTOPPING WORK

A. General: Provide solid continuous firestopping wherever the penetration or addition of a construction element through or adjacent to a fire-rated floor, wall or partition, or roof creates a discontinuity of such a rated separation. Application limited in size and configuration to tested systems. Do not install insulation types specified in other Sections in lieu of specified firestopping materials.

B. Interior Walls and Partitions: Where top edge of a fire-rated wall or partition abuts a fluted-type metal deck, provide mineral fiber and fire-rated sealant to fill flute spaces for the full depth or width of the wall or partition.
C. **Penetrations:**
1. Penetrations include conduit, cable, wire, pipe, duct, and other elements which pass through one or both outer surfaces of a fire-rated floor, roof, wall, or partition.
2. Verify that annular space around sprinkler pipes through fire-rated walls and floors is provided as required by NFPA 13.

D. **Fire Rated Partitions:**
1. Gaps exceeding 1/2-inch at smoke rated and fire-rated partitions shall be firestopped with a firestop sealant as listed in UL "Fire Resistance Directory" and as specified. Apply minimum 3/8-inch bead at intersection of finish material and adjacent surface, both sides and along entire perimeter.
2. Intersections at fire-rated partitions and steel deck type floor-ceiling or roof-ceiling assemblies shall be firestopped as required.

E. **Provide firestopping to fill miscellaneous voids or openings at fire-rated construction as specified.**

3.04 **INSTALLATION**

A. Do not install firestopping until building is sufficiently enclosed or protected against adverse weather conditions, and supporting framing and surrounding construction is in a dry condition.

B. Prepare and install firestopping in accordance with manufacturer's instructions.

C. **Mineral Fiber:**
1. Provide in thickness for compressing into voids for a tight friction fit when installed.
2. Provide in width sufficient to fill the depth of the void space using single width pieces.
3. Install with ends tight against terminal end construction, and with intermediate joints well compressed together and tight.
4. For vertical void spaces, provide support clips near each end, spaced not over 24-inches on center.

D. **Foam:**
1. Provide form materials to retain foam when placed.
2. Prime contact surfaces as recommended by foam manufacturer.
3. Inject foam into void spaces so foam develops full and complete contact with adjoining surfaces, and the space is free from air pockets.
4. Cure foam 24-hours, remove form materials not required to remain, and inspect.
5. Provide additional foam or sealant to fill insufficient depth and remaining voids.

E. **Sealants:**
1. Prepare penetrations in vertical and horizontal surfaces as required to receive finish products.
2. Install damming materials as required.
3. Apply caulk or putty in accordance with manufacturer's recommendations.

F. **Steel Deck Plugs:** Provide at steel deck flutes at all full-height sound-rated partitions unless otherwise indicated.

G. **Finish surfaces of exposed to view firestopping to a uniform and level condition.**

H. **Firestopping shall not extend past edges of cover plates, escutcheons, etc. or where it will be exposed to view in...**
the final assembly.

I. Install escutcheon plates at pipes and conduit exposed to view.

3.05 FIELD QUALITY CONTROL

A. Identify firestop systems after installation. Identify the firestop system that has been installed and include the appropriate UL Design Number.

B. At fire-rated walls, partitions, smoke barriers and other walls required to have protected openings or penetrations, provide a sign or stenciling on the wall above the suspended ceiling stating that penetrations through fire-rated walls and partitions are not permitted unless such penetrations or openings are protected with firestopping meeting code requirements. Letters shall not be less than 1/2-inch in height. Repeat at intervals not exceeding 30-feet measured horizontally. Signs or stenciling shall comply with 2009 IBC/2010 CBC requirements.

3.06 CLEANING

A. Remove spilled and excess materials without damaging adjacent surfaces.

B. Leave finished work in neat, clean condition with no evidence of spill-overs or damage to adjacent surfaces.

3.07 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Close and seal tightly all partly used sealant containers and store protected in well ventilated fire-safe area at moderate temperatures.

C. Place used sealant tubes and containers in areas designated for hazardous materials.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing joint sealants.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Firestopping sealants are specified in Section 07840.
   3. Acoustical joint sealants are specified in Section 07922.
   4. Glazing sealants are specified in Section 08800.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer's technical data for each product required, including instructions for joint preparation and sealant application. Include certification by joint sealant manufacturer that sealants, primers, and cleaners comply with local regulations controlling the use of volatile organic compounds (VOC).
C. Samples: Manufacturer's bead samples of actual products showing full range of colors available, for each product exposed to view.
D. Test Reports: Certified test results of elastomeric sealants showing compliance with specified requirements. Include results of aged performances including hardness, stain-resistance, adhesion and cohesion under cyclic movement, low temperature flexibility, modulus of elasticity at 100-percent strain, affects of heat and aging, and affects of accelerated weathering.
E. Certificates: Manufacturer's certification that joint sealants comply with specified requirements and are suitable for uses indicated.

1.03 QUALITY ASSURANCE
A. Installer's Qualifications: Completion of at least 3 installations similar in type and size to this Project.
B. Obtain joint sealant materials from a single manufacturer for each product required unless otherwise approved.
C. Preconstruction Compatibility and Adhesion Testing: Submit sample substrate materials to be sealed to joint sealant manufacturer for testing of adhesion and for compatibility with secondary seals.
   1. Determine if priming and/or other preparation techniques are required.
   2. Testing for adhesion is not required if sealant manufacturer has performed previous testing of proposed sealants for adhesion to and compatibility with required joints substrates.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. Do not use products containing the following materials:
   1. Methylene Chloride or Chlorinated Hydrocarbons.
   2. Bactericides and fungicides that are classified as Phenol mercury acetates, phenol phenates, or phenol formaldehyde.
   3. Aromatic and aliphatic solvents.
4. Styrene Butadiene.

B. Adhesives, sealants and primers applied to the building interior shall meet the VOC limits established in the South Coast Air Quality management District Rule #1168, July 1, 2005 and rule amendment date of January 7, 2007.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with the requirements specified in Division 1.

B. Deliver materials in the unopened, original containers or unopened packages with manufacturer's name, labels, product identification, color, expiration period, curing time and mixing instructions for multi-component materials.

C. Store materials in the original, unopened containers or packages, and under conditions recommended by manufacturers.

1.06 PROJECT CONDITIONS

A. Environmental Conditions: Do not install sealants when ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer, or to wet joint substrates.

B. Joint Width Conditions: Do not install sealants when joint widths are less than permitted by sealant manufacturer.

C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Provide joint sealers, joint fillers and other materials that are compatible with one another and with joint substrates, as demonstrated by testing and field experience.

B. Joint Sealant Colors: As selected by the Architect.

2.02 ELASTOMERIC JOINT SEALANTS

A. Sanitary Sealant: One-part mildew-resistant silicone; ASTM C920 Type S; Grade NS; Class 25; Uses NT, G, A and O; formulated with fungicide for sealing interior joints with nonporous substrates around ceramic tile, showers, sinks and plumbing fixtures; Dow Corning Corp. "786 Mildew Resistant", GE "Sanitary 1700", Sonneborn Building Product Div. "Sonolastic Omniplus", Tremco Tremsil 200 or approved equal.

B. Horizontal Joint Sealant: Two-part pourable urethane; ASTM C920, Type M; Grade P; Class 25; Uses T, M, A and O; Pecora Corp. "NR-200 Urexpan", Sonneborn "Sonolastic Paving Joint Sealant", Tremco, Inc. "THC-900/901" or approved equal. Horizontal joint sealant shall have a minimum Shore A hardness of 30.

2.03 LATEX JOINT SEALANTS

A. Interior Building Sealant: Acrylic-emulsion; one-part, nonsag, mildew-resistant, complying with ASTM C834, formulated to be paintable; Pecora Corp. "AC-20", Sonneborn "Sonolac", Tremco Inc. "Tremco Acrylic Latex 834" or approved equal.

2.04 JOINT FILLERS FOR CONCRETE PAVING

A. Joint Filler: Preformed cork strips complying with ASTM D1752 for Type II or preformed sponge rubber strips complying with ASTM D1752 for Type I.

2.05 JOINT SEALANT BACKING

A. General: Provide sealant backings which are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved by sealant manufacturer.

B. Plastic Foam Joint-Fillers: Preformed, compressible, resilient, non-waxing, non-extruding strips of plastic foam,
size, shape and density to control sealant depth.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer. Provide self-adhesive tape where applicable.

2.06 MISCELLANEOUS MATERIALS

A. Primer: As recommended by joint sealant manufacturer for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Non-staining, chemical cleaner of type acceptable to manufacturer of sealant and sealant backing materials which are not harmful to substrates and adjacent nonporous materials.

C. Masking Tape: Non-staining, non-absorbent type compatible with joint sealants and to surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants.

1. Remove foreign material from joint substrates which could interfere with adhesion of joint sealant, including dust, paints, oil, grease, waterproofing, water repellents, water, and surface dirt.

2. Clean porous surfaces, by brushing, grinding, blast cleaning, mechanical abrading, or acid washing to produce a clean, sound substrate. Remove loose particles remaining from cleaning operations by vacuuming or blowing out joints.

3. Remove laitance and form release agents from concrete.

4. Clean non-porous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint sealant manufacturer. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond, do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces. Remove tape immediately after tooling without disturbing joint seal.

3.02 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply. Provide temporary ventilation during installation of interior joint sealants.

B. Sealant Installation Standard: Comply with recommendations of ASTM C1193 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:

1. Install joint-fillers to provide sealant support for optimum performance cross-sectional shapes and depths.

   a. Do not leave gaps between ends of joint-fillers.

   b. Do not stretch, twist, puncture or tear joint-fillers.

   c. Remove absorbent joint-fillers which have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants and joint-fillers, compression seals or back of joints where required to prevent third-side adhesion of sealant to back of joint.
D. Installation of Sealants: Install sealants by proven techniques to contact and full wet joint substrates, completely filling recesses provided for each joint configuration and providing uniform, optimum performance cross-sectional shapes and depths.

E. Tooling of Non-sag Sealants: Tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.03 PROTECTION AND CLEANING
A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage.
B. Cut out and remove damaged or deteriorated joint sealers and reseal joints with matching new materials.
C. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by sealant manufacturer.

3.04 CONSTRUCTION WASTE MANAGEMENT
A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.
B. Close and seal tightly all partly used sealant containers and store protected in well ventilated fire-safe area at moderate temperatures.
C. Place used sealant tubes and containers in areas designated for hazardous materials.

END OF SECTION
SECTION 07922
ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing acoustical joint sealants.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Joint sealants are specified in Section 07920.
   3. Acoustic insulation is specified in Section 09810.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer's technical data for each product required, including instructions for joint preparation and sealant application. Include certification by joint sealant manufacturer that sealants, primers, and cleaners comply with local regulations controlling the use of volatile organic compounds (VOC).
C. Samples: Manufacturer's bead samples of actual products showing full range of colors available, for each product exposed to view.
D. Certificates: Manufacturer's certification that joint sealants comply with specified requirements and are suitable for uses indicated.

1.03 QUALITY ASSURANCE
A. Installer's Qualifications: Completion of at least 3 installations similar in type and size to this Project.
B. Obtain joint sealant materials from a single manufacturer for each product required unless otherwise approved.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. Do not use products containing the following:
   1. Methylene Chloride or Chlorinated Hydrocarbons.
   2. Bactericides and fungicides that are classified as Phenol mercury acetates, phenol phenates, or phenol formaldehyde.
   3. Aromatic and aliphatic solvents.
   4. Styrene Butadiene.
B. Adhesives, sealants and sealant primers shall not exceed the VOC limits established in South Coast Air Quality Management District Rule 1168, effective date of July 1, 2005 and rule amendment date of January 7, 2005.

1.05 DELIVERY, STORAGE, AND HANDLING
A. General: Comply with the requirements specified in Division 1.
B. Deliver materials in the unopened, original containers or unopened packages with manufacturer's name, labels, product identification, color, expiration period, curing time and mixing instructions for multi-component materials.
C. Store materials in the original, unopened containers or packages, and under conditions recommended by manufacturers.

1.06 PROJECT CONDITIONS

A. Environmental Conditions: Do not install sealants when ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer, or to wet joint substrates.

B. Joint Width Conditions: Do not install sealants when joint widths are less than permitted by sealant manufacturer.

C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.01 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Concealed Joints: Non-drying, non-hardening, non-skinning, non-staining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound; Pecora Corp. "BA-98", Tremco Inc. "Tremco Acoustical Sealant", USG "Sheetrock Acoustical Sealant" or approved equal.

B. Acoustical Sealant for Exposed Joints: Non-oxidizing, skinnable, paintable, gunnable sealant recommended for sealing interior exposed joints to reduce transmission of airborne sound; Pecora Corp. "AC-20 FTR Acoustical and Insulation Sealant", USG "Sheetrock Acoustical Sealant" or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's instructions for installation conditions.

B. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C919 for use of joint sealants in acoustical applications as applicable to materials, applications and conditions indicated. Install sealants in accordance with manufacturer’s instructions.

3.02 PROTECTION

A. Protect installed insulation from harmful exposures and from physical damage.

3.03 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Close and seal tightly all partly used sealant containers and store protected in a well ventilated fire-safe area at moderate temperatures.

C. Place used sealant tubes and containers in areas designated for hazardous materials.

END OF SECTION
SECTION 08110
STEEL FRAMES

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing hollow metal door frames, interior window frames, and associated accessories.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Flush wood doors are specified in Section 08212.
   3. Door hardware is specified in Section 08710.
   4. Glass and glazing is specified in Section 08800.
   5. Painting is specified in Section 09900.

1.02 SUBMITTALS
A. General: Comply with Division 1.
B. Product Data: Furnish for each type of frame, including details of construction, materials, dimensions, hardware preparation, label compliance, profiles, and finishes.
C. Shop Drawings: Include details of each frame type, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items. Reference architectural details, door number and hardware group.
D. Door Schedule: Furnish complete schedule of frames using same reference numbers for details and openings as those on the drawings.

1.03 QUALITY ASSURANCE
A. Steel frames shall comply with ANSI A250.8 "Recommended Specifications Standard Steel Doors and Frames" and the specified requirements.
B. Fire-Rated Assemblies: Units shall comply with CBC, and be identical to door and frame assemblies whose fire resistance characteristics have been determined in accordance with SFM Standard 12-7-4 and are labeled and listed by UL, Factory Mutual, Warnock Hersey, or other testing and inspecting organization acceptable to authorities having jurisdiction.
C. Steel frames shall comply with positive pressure test requirements of SFM Standard 12-7-4 and shall be labeled accordingly by the door and frame manufacturer in a manner approved by authorities having jurisdiction.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
C. Hollow metal doors and frames shall have a minimum of 20-percent recycled content.
1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1.

B. Deliver frames cardboard-wrapped or crated to provide protection during transit and job storage.

C. Inspect frames upon delivery for damage. Minor damage may be repaired provided finish items are equal to new work and acceptable to Architect; otherwise remove and replace damaged items as directed.

D. Store frames at building site under cover. Place units on minimum 4-inch high wood blocking. Avoid use of non-vented plastic or canvas shelters that could create humidity chamber.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Steelcraft or approved equal.

2.02 MATERIALS

A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A569.

B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A366, commercial quality or ASTM A620, drawing quality.

C. Supports and Anchors: Fabricate of not less than 16-gauge, galvanized where used with galvanized frames.

D. Inserts, Bolts and Fasteners: Manufacturer's standard units.

E. Shop Applied Primer: Rust-inhibitive enamel or paint, either air drying or baking, suitable as a base for specified finish paints.

2.03 DOOR FRAMES

A. One-Piece Welded Frames: 16-gauge. Fabricate frames with mitered or coped and continuously welded corners.

B. Glazing Beads: Provide frame glazing beads in interior glazed openings and other locations where fixed glass is indicated. Prepare frames for the type of glazing beads required to receive the glass and gaskets indicated. Miter or butt join beads at corners. Glazing beads shall be screw-on type to receive countersunk flat head machine screws.

C. Anchors:

1. Provide a jamb anchor for each 2'-6" of door or window height or fraction thereof.

2. Fabricate from minimum 16-gauge sheet steel.

3. Vary anchor types to provide positive fastening to adjacent construction.

4. Secure a metal clip angle at bottom of each jamb member for anchoring to floor, with a minimum of two fasteners.

D. Door Silencers: Except on weatherstripped or smoke gasketed frames, drill stops to receive 3-silencers on strike jambs of single-swing frames and 2-silencers in heads of double-swing frames.

E. Plaster Guards: Provide 26-gauge steel plaster guards or mortar boxes at back of hardware cutouts.
2.04 FABRICATION

A. Fabricate steel frames to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer’s plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at Project site. Comply with ANSI A250.8 requirements.

B. Tolerances: Comply with SDI-117, "Manufacturing Tolerances Standard Steel Doors and Frames" unless otherwise indicated or specified.

C. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot-rolled steel.

D. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat heads for exposed screws and bolts.

E. Hardware Preparation: Prepare frames to receive mortised and concealed hardware in accordance with final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A250.6 for door frame preparation for hardware.
   1. For concealed overhead door closers, provide space, cutouts, reinforcing and provisions for fastening in head of frames, as applicable.

F. Reinforce frames to receive surface-applied hardware. Drilling and tapping of surface-applied hardware may be done at Project site.

G. Locate hardware as indicated on final shop drawings and in accordance with Door Hardware Institute (DHI) “Recommended Locations for Builder’s Hardware on Standard Steel Doors and Frames”.

H. Shop Painting: Clean, treat, and paint exposed surfaces of steel frame units, including galvanized surfaces.
   1. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.
   2. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive paint finish.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install steel frames and accessories in accordance with the manufacturer's instructions, the requirements of ANSI/SDI, and final reviewed Shop Drawings.

B. Placing Frames: Comply with provisions of ANSI A250.8 and SDI-112 unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   1. Except for frames located in concrete, place frames before constructing enclosing walls or ceilings.
   2. In masonry construction, install at least 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
   3. At existing concrete or masonry construction, install at least 3 completed opening anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.
   4. In stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. Attach wall anchors to studs with screws.
   5. Install fire-rated frames according to their listings.
6. Install head anchors at mid span for openings exceeding 48-inches.

3.02 ADJUST AND CLEAN

A. Immediately after installation, sand smooth rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

1. Remove rust before touch-up is applied.

2. Touch-up shall not be obvious.

B. When complete, exposed surfaces and edges shall be clean, straight, and free from dents, scratches, and other damage and defects.

3.03 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.
SECTION 08121
INTERIOR ALUMINUM DOOR AND GLAZING FRAMES

PART 1 – GENERAL

1.01 DESCRIPTION
A. This Section includes pre-finished interior aluminum door and sidelight frames.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Door hardware is specified in Section 08710.
   3. Glass and glazing is specified in Section 08800.

1.02 SUBMITTALS
A. General: Comply with Division 1.
B. Product Data: Furnish for each type of frame, including details of construction, materials, dimensions, hardware preparation, label compliance, profiles, and finishes.
C. Shop Drawings: Include details of each frame type, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items. Reference architectural details, door number and hardware group.
D. Door Schedule: Furnish complete schedule of frames using same reference numbers for details and openings as those on the drawings.

1.03 ENVIRONMENTAL QUALITY ASSURANCE
C. Aluminum door and glazing frames shall have a minimum of 20-percent recycled content.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. General: Comply with Division 1.
B. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage.
C. Inspect doors and frames upon delivery for damage. Minor damage may be repaired provided finish items are equal to new work and acceptable to Architect; otherwise remove and replace damaged items as directed.
D. Store doors and frames at building site under cover. Place units on minimum 4-inch high wood blocking. Avoid use of non-vented plastic or canvas shelters that could create humidity chamber.
PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Western Integrated Materials, Inc. with 1-1/2-inch Profile Trim or approved equal.

2.02 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by manufacturer.

B. Fasteners: Screws, nuts, washers and similar fasteners shall be aluminum, stainless steel or other non-corrosive material compatible with aluminum. Exposed fasteners are not acceptable.

C. Glazing Gaskets: Manufacturer’s standard vinyl gaskets.

2.03 FABRICATION

A. Fabricate aluminum frames at manufacturer’s shop prior to application of finish; profiles and shapes as indicated. Fabricate frames for center mounting glass panels.

B. Fabricate frames for attachment to partitions with concealed fasteners.

C. Provide steel attachment clips for extrusion intersections.

D. Fabricate frames to permit installation over prefinished walls.

E. Provide continuous nylon backed wool pile sound and light-seal around perimeter of door stops.

F. Prepare aluminum door frames to receive hardware from reviewed hardware schedule, hardware templates, and hardware samples furnished by hardware supplier. Include reinforcements as required. Drill and tap mortised reinforcements at factory.

G. Provide matching sidelight frames where indicated.

2.04 FINISH

A. Finish: Factory-applied clear anodized aluminum.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install aluminum frames in accordance with manufacturer’s instructions and reviewed shop drawings.

B. Securely anchor frames straight, plumb and level without distortion.

C. Corners shall be accurately joined, reinforced and fitted to flush hairline joints.

3.02 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.
SECTION 08212
FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section describes the requirements for furnishing and installing flush wood doors.

B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Steel frames are specified in Section 08110.
   3. Door hardware is specified in Section 08710.
   4. Glass for vision panels is specified in Section 08800.

1.02 SUBMITTALS

A. General: Comply with Division 1.

B. Product Data: Manufacturer's descriptive and technical data and illustrations for each type of door including details of core and edge construction, and trim for openings.

C. Shop Drawings: Indicate location and size of each door, elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, requirements for factory finishing and other data.
   1. Shop drawings shall comply with AWS Section 1 – Submittals.
   2. Furnish a Woodwork Institute “Certified Compliance Label” on the first page of the shop drawings.

D. Samples:
   1. Submit 24-inch square or larger samples as specified or required to represent required characteristics. Resubmit samples until approved.
      a. Doors for Transparent Finish: Door faces with solid wood edging representing typical range of color and grain for each species of veneer. Samples shall be representative of the complete range of wood veneer colors to be expected in the work.
   2. Furnish full-size door for transparent finish showing the complete range of color and grain to be expected in the completed work. Resubmit until sample is approved by the Architect. Approved sample will be used to judge the acceptability of transparent finished door veneer and may be used in the Project.

E. Warranty.

1.03 QUALITY ASSURANCE

A. Flush wood door construction shall comply with Architectural Woodwork Standards (AWS) for Premium grade doors.

B. Fire-Rated Doors: Provide wood doors that comply with California Building Code (CBC) Section 715; are identical in materials and construction to units tested in door and frame assemblies in accordance with NFPA 252 or UL 10C; and are labeled and listed by UL, Warnock Hersey, or other testing and inspection agency acceptable to authorities having jurisdiction. Labels shall comply with NFPA 80 and be permanently affixed to the door.
C. Allowable Tolerances:

1. Warp Tolerance: As specified in Section WDMA T-2. In addition, warp tolerance shall apply to pairs of doors and to doors in relation to the frame or jamb in which hung.


3. Gap Tolerance: As specified in Architectural Woodwork Standards Section 9, Section 4.3.8 and Section 6.1.20.


D. Flush wood doors and steel frames specified in Section 08110 shall comply with positive pressure test requirements of NFPA 252 or UL 10C and shall be labeled accordingly by the door and frame manufacturer in a manner approved by authorities having jurisdiction. Door label shall include hourly rating followed by the letter “S” indicating conformance with air leakage resistance testing, serial number, and the listing agency’s certification mark.

E. Temperature-Rise Rating: At exit enclosures and exitways, provide doors that have a temperature-rise rating of 450 deg F maximum in 30 minutes of fire exposure. In addition to the requirements specified for positive pressure test requirements in Paragraph D. above, the door label shall include temperature rise rating.

F. WI Certified Compliance Program (CCP):

1. Before delivery to the Project site, provide a Woodwork Institute Certified Compliance Certificate itemizing the products to be provided and certifying that they meet the requirements of the Architectural Woodwork Standards and of the Plans and Specifications.

2. Upon completion of installation, furnish a WI Certified Compliance Certificate for the installation.

3. In the event of question as to compliance with the referenced standard of any item of work, the Architect may require independent inspection service of questioned items as specified in “Independent Inspection Service” of WI “Services and Quality Control Options” published by the WI.

1.04 ENVIRONMENTAL QUALITY ASSURANCE

A. Do not use composite wood and agrifiber products that contain added urea formaldehyde resin.

B. Laminating adhesives use to fabricate composite wood and agrifiber assemblies shall not contain added urea formaldehyde resins.

C. Wood products shall originate in forests that are certified according to the rules of the Forest Stewardship Council (FSC). Approved vendors are available online at www.fscus.org.

1. FSC-accredited certifying agencies include the following:

   a. Smart Wood Program (www.smartwood.org).


   c. SGS Qualifor (www.qualifor.com).


2. Follow proper procedures to ensure that certified wood products are kept separate from non-certified materials and that auditing procedures as mandated by the certifier are complied with.

3. Submission of a Chain of Custody certificate without an invoice or submission of an invoice without a Chain of Custody certificate shall not constitute acceptable documentation.
4. Proper procedures shall be followed to ensure that certified wood products are kept separate from non-certified materials and that auditing procedures as mandated by the certifier are complied with.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1.

B. Deliver doors individually protected with polyvinyl or plastic wrap, identified with manufacturer's name, and name and type of door. Identify each door with same symbol used on door schedule. Leave protection on door during construction.

1. Comply with Architectural Woodwork Standards (AWS) – Section 2 for delivery, storage, and handling of doors.

C. Store doors covered and flat, supported above a level surface in a dry, well ventilated building in compliance with Architectural Woodwork Standards (AWS) – Section 2.

D. Do not subject doors to extremely high or low temperatures or humidity.

E. Handle with clean gloves; do not drag doors across one another or other surfaces.

F. Certain wood species are light sensitive. Protect doors from exposure to natural and artificial light after delivery.

1.06 PROJECT CONDITIONS

A. Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of construction period in compliance with the requirements specified in Architectural Woodwork Standards (AWS) – Section 2.

1.07 WARRANTY

A. Warrant each solid core interior door against defects in materials and workmanship for the life of the original installation, including costs of re-hanging. Defects include, but are not limited to the following:

1. Cores shall not telegraph through door faces. Stile, rail, and core show-through shall be considered a defect when the face of the door varies from a true plane in excess of 0.010-inch in a 3-inch span.

2. Doors shall not have warped (bow, cup, or twist) more than that permitted in Architectural Woodwork Standards (AWS) Section 6.1.21.

B. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Marshfield Door Systems or approved equal.

2.02 FLUSH WOOD DOORS, GENERAL

A. Type: Flush veneered, five-ply construction. Doors with seven-ply construction will not be acceptable.

B. Door Grade: Fabricate flush wood doors to receive transparent finish in accordance with Architectural Woodwork Standards (AWS), Premium Grade.

C. Cross Banding: Manufacturer's standard, minimum 1/16-inch thick. Fire-retardant treated where required by testing agency.

D. Door Thickness: 1-3/4-inches, unless otherwise indicated.
E. Fabricate wood doors in sizes indicated for either job-site fitting or factory fit doors to suit frame-opening sizes indicated, at the Contractor's option. Doors shall comply with the following uniform clearances and bevels:

1. Non-rated Doors:
   c. Bottom of Door to Top of Finish Floor: 1/2-inch at concrete and resilient flooring, 3/8-inch at carpet, tile, threshold and other finish flooring.

2. Fire-rated Doors: Comply with requirements of CBC Section 715 and NFPA 80.

F. For doors that are pre-machined, factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame shop drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with factory machining.

G. Factory Finishing:

1. Transparent Finish Doors: Prefinish to match Architect approved samples as follows:
   a. Architectural Woodwork Standards (AWS) Section 5, Premium Grade.
   b. Finish: Manufacturer's standard finish with performance requirements comparable to Architectural Woodwork Standards (AWS) Section 5, System 12 – Polyurethane, Water-Based, complying with VOC requirements.
   c. Staining: Match Architect approved sample.
   d. Effect: Filled finish.
   e. Sheen: Satin, 31- to 45-degrees.

2.03 INTERIOR FLUSH WOOD DOORS

A. Veneer:

1. Transparent Finish Doors
   a. Veneer Species and Grade: Architectural Woodwork Standards (AWS) Grade AA, species and cut to match existing.
   b. Veneer Matching: Match existing.
   c. Pairs and Sets: Provide pair matching and set matching for pairs of doors and for doors hung in adjacent sets.
   d. Doors in same room or area shall be matched for color and grain.

2. Veneer shall comply with Section 01352 requirements.

B. Adhesive: NWWDIA IS-1.6, Type II adhesive bond or better for cores, Type I adhesive bond for faces and cross bands.
C. Cores:

1. 20-Minute Fire-Rated Doors and Non-rated Doors (PC-5): Solid particleboard conforming to ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde resin.


3. Where the distance between the lock cutout and the vision lite cutout require, provide door manufacturer's structural composite lumber core (SCLC-5). Notify the Architect if the vision lite size and lock location exceeds door manufacturer's maximum dimension.

D. Edge Construction:

1. 20-Minute Fire-Rated Doors and Non-rated Doors:
   a. Stiles and Rails: Minimum 1-3/8-inch wide by full core thickness glued to core. Provide wider hinge stile where recommended by door manufacturer for door size and type of hinges to be used. Exposed edges of stiles shall be smooth, straight cut, free from knots, pitch pockets, and other defects for a minimum distance of 1/4-inch from the outside edge along the entire stile.
   b. Species:
      1) Stiles: Same species as face for doors to receive transparent finish with no finger joints permitted on lock stiles.
      2) Rails: Hardwood or softwood at manufacturer's option.
   c. Edge Banding: Minimum 1/2-inch wide by full core thickness. Edge bands if used may reduce the width of stiles and rails.
      1) Species for doors to receive transparent finish shall be same as face with no finger joints permitted on lock stile.

2. Fire-Rated Doors Greater than 20-Minute Rated:
   a. Top Rail: Door manufacturer's standard special laminated material.
   b. Stiles and Rails: Hardwood, fire-retardant treated where required by label. Where not required to be fire-retardant treated, provide same species for stiles as face veneer for doors to receive transparent finish. Sizes required by testing agency.

3. Bevel non-rated doors 1/8-inch in 2-inches at lock and hinge edges.

4. Bevel fire-rated doors 1/8-inch in 2-inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

2.04 DOOR LOUVERS

A. Type: Prefabricated 20-gauge steel units.

B. Opening Sizes: As scheduled.

C. Finish: Manufacturer's standard baked-enamel finish, of color selected by Architect.

2.05 LIGHT FRAMES

A. Non-Rated Doors and 20 Minute Fire-Rated Doors: Same wood species as door faces, profile as indicated.
B. Fire-Rated Doors over 20 minutes: Manufacturer’s standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire ratings indicated. Include concealed metal glazing clips where required for opening size and fire ratings scheduled.

PART 3 - EXECUTION

3.01 INSPECTION
A. Examine door frames and verify that frames are of the correct type and have been installed as required for proper hanging of corresponding doors. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Condition doors to average prevailing humidity in installation area prior to hanging.

3.03 INSTALLATION
A. Install wood doors in accordance with the manufacturer’s printed instructions, as indicated and in accordance with Architectural Woodwork Standards, Section 9.
B. Factory-finished doors shall be installed just prior to Substantial Completion.
C. Fire-Rated Doors: Install in fire-rated frames in accordance with requirements of NFPA Standard No. 80.
D. Job-Fit Doors: For doors not factory-machined, align and fit doors in frames with uniform clearances and bevels as specified; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.

1. Fitting Clearances:
   a. Non-rated Doors:
      1) Jambs and Heads: 1/8-inch.
      3) Bottom of Door to Top of Finish Floor: 1/2-inch at concrete and resilient flooring, 3/8-inch at carpet, tile, thresholds and other finish flooring.
   b. Fire-rated Doors: As specified in CBC Section 715 and NFPA 80.

2. Bevel non-rated doors 1/8-inch in 2-inches at lock and hinge edges.
3. Bevel fire-rated doors 1/8-inch in 2-inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
F. Cutouts, Recesses, and Exposed Rail Edges: Unless factory provided, paint with two coats of clear sealer, each coat well dried, before hardware is set in place.
G. Meeting stiles of pairs of doors shall be in alignment along the entire height, and offset between adjacent leaves shall not exceed 1/8-inch.

3.04 ADJUSTING AND PROTECTION
A. When complete, doors shall be flat within allowable tolerance, shall be plumb in all positions of swing, and shall operate smoothly, quietly, and free from binding. Re-hang or replace doors that do not swing or operate freely.
B. Exposed surfaces shall be uniform in appearance, clean and free from scratches, tool marks, dents, discoloration, stains, and other damage and defects.
C. Refinish or replace doors damaged during installation.

D. Protect doors as recommended by door manufacturer to ensure that doors will be without damage or deterioration at completion of Project.

3.05 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

END OF SECTION
SECTION 08710
FINISH HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions of Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.

B. This Section includes the following, but is not necessarily limited to:
   1. Door Hardware, including electric hardware.
   2. Storefront and Entrance door hardware.
   3. Power supplies for electric hardware.
   4. Thresholds, gasketing and weather-stripping.
   5. Door silencers or mutes.

C. Related Sections: The following sections are noted as containing requirements that relate to this Section, but may not be limited to this listing.
   D. Section 08110 - Steel Doors and Frames.
   E. Section 08210 - Wood Doors.
   F. Section 08400 - Entrances and Storefronts.

1.03 REFERENCES (Use date of standard in effect as of Bid date.)

B. BHMA - Builders' Hardware Manufacturers Association.
C. CCR - California Code of Regulations, Title 24, Part 2, California State Accessibility Standards.
D. DHI - Door and Hardware Institute.
   1. NFPA 80 - Fire Doors and Windows
   3. NFPA 105 - Smoke and Draft Control Door Assemblies
F. CBC - California Building Code.
G. UL - Underwriters Laboratories.
   1. UL 10C - Fire Tests of Door Assemblies
   2. UL 305 - Panic Hardware
H. WHI - Warnock Hersey Incorporated
I. SDI - Steel Door Institute
1.04 SUBMITTALS & SUBSTITUTIONS

A. General: Submit in accordance with Conditions of the Contract and Division 1 Specification sections.

B. Submit product data (catalog cuts) including manufacturers' technical product information for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

C. Submit six (6) copies of schedule organized vertically into "Hardware Sets" with index of doors and headings, indicating complete designations of every item required for each door or opening. Include following information:

1. Type, style, function, size and finish of each hardware item.
2. Name, part number and manufacturer of each item.
3. Fastenings and other pertinent information.
4. Location of hardware set coordinated with floor plans and door schedule.
5. Explanation of all abbreviations symbols and codes contained in schedule.
6. Mounting locations for hardware.
7. Door and frame sizes and materials.
8. List of manufacturers used and their nearest representative with address and phone number.

D. Make substitution requests in accordance with Division 1. Substitution requests must be made prior to bid date. Include product data and indicate benefit to the project. Furnish samples of any proposed substitution.

E. Wiring Diagrams: Provide product data and wiring and riser diagrams for all electrical products listed in the Hardware Schedule portion of this section.

F. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

G. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

H. Furnish as-built/as-installed schedule with closeout documents, including keying schedule, wiring/riser diagrams, manufacturers' installation, adjustment and maintenance information.

1.05 QUALITY ASSURANCE

A. Obtain each type of hardware (latch and lock sets, hinges, closers, exit devices, etc.) from a single manufacturer.

B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.

1. Responsible for detailing, scheduling and ordering of finish hardware.
2. Meet with Owner to finalize keying requirements and to obtain final instructions in writing.
3. Stock parts for products supplied and be capable of repairing and replacing hardware items found defective within warranty periods.

C. Hardware Installer: Company specializing in the installation of commercial door hardware with five years documented experience.
D. **Fire-Rated Openings:** Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and tested by UL or Warnock Hersey for given type/size opening and degree of label. Provide proper latching hardware, door closers, approved-bearing hinges and seals whether listed in the Hardware Schedule or not.
   
   1. Where emergency exit devices are required on fire-rated doors, (with supplementary marking on doors' UL labels indicating "Fire Door to be Equipped with Fire Exit Hardware") provide UL label on exit devices indicating "Fire Exit Hardware".

E. **Exit Doors:** Operable from inside with single motion without the use of a key or special knowledge or effort.

1.06 **DELIVERY, STORAGE AND HANDLING**

A. Coordinate delivery of packaged hardware items to the appropriate locations (shop or field) for installation.

B. Hardware items shall be individually packaged in manufacturers' original containers, complete with proper fasteners. Clearly mark packages on outside to indicate contents and locations in hardware schedule and in work.

C. Provide locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, etc.

D. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

1.07 **WARRANTY**

A. Provide warranties of respective manufacturers' regular terms of sale from day of final acceptance as follows:
   
   1. Closers: Ten (10) years, except electronic closers, which shall be two (2) years.
   2. Exit devices: Three (3) years.
   3. Locksets: Seven (7) years.
   4. All other hardware: Two (2) years.

1.08 **MAINTENANCE**

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.09 **PRE-INSTALLATION CONFERENCE**

A. Convene a pre-installation conference at least one week prior to beginning work of this section.

B. Attendance: Architect, Construction Manager, Contractor, hardware supplier, installer, key District personnel, and Project Inspector.

C. Agenda: Review hardware schedule, products, installation procedures and coordination required with related work. Review District's keying standards.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

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2.02 MATERIALS

A. Hinges: Exterior out-swinging door butts shall be non-ferrous material and shall have stainless steel hinge pins. All doors to have non-rising pins.

1. Hinges shall be sized in accordance with the following:
   a. Height:
      1) Doors up to 41" wide: 4-1/2" inches.
      2) Doors 42" to 48" wide: 5 inches.
   b. Width: Sufficient to clear frame and trim when door swings 180 degrees.
   c. Number of Hinges: Furnish 3 hinges per leaf to 7'-5" in height. Add one for each additional 2 feet in height.
   d. Furnish non-removable pins (NRP) at all exterior out-swing doors and interior key lock doors with reverse bevels.

B. Pivots: High strength forgings and castings with precision bearings for smooth operation. Positive locking vertical adjustment mechanism to allow installer to precisely position the door and balance the load.

C. Heavy Duty Cylindrical Locks and Latches: Schlage "ND" Series as scheduled with "Sparta" design, fastened with through-bolts and threaded chassis hubs.

1. Chassis: Cylindrical design, corrosion-resistant plated cold-rolled steel.
2. Locking spindle: Stainless steel, one piece interlocking design.
4. Lever Trim: Accessible design, independent operation, spring-cage supported, minimum 2” clearance from lever mid-point to door face.
5. Locks shall be of such construction that when locked, the door may be opened from within by using lever and without the use of a key or special knowledge.
6. Rosettes: Minimum 3-7/16” diameter for coverage of ANSI/DHI A115.18, 1994 door preparation, through-bolt lugs on both spring cages to fully engage this pattern.
7. Springs: Full compression type
8. Strikes: 16 gage curved steel, bronze or brass with 1” deep box construction, lips of sufficient length to clear trim and protect clothing.

D. Exit devices: Von Duprin as scheduled with Push-through pad design, no exposed touch bar fasteners, no exposed cavities when operated.
1. Provide certificate by independent testing laboratory that device has completed over 1,000,000 cycles and can still meet ANSI/BHMA A156.3 - 1994 standards.
2. All internal parts shall be of cold-rolled steel with zinc dichromate coating.
3. Mechanism case shall have an average thickness of .140”.
4. Compression spring engineering.
5. Non-handed basic device design with center case interchangeable with all functions.
6. All devices shall have quiet return fluid dampeners.
7. All latchbolts shall be deadlocking with ¾” throw and have a self-lubricating coating to reduce friction and wear.
8. Device push bar must release when a force of 32 pounds, or less, of pressure is applied when a force of 250 pounds is applied to the door.
9. Device shall bear UL label for fire and or panic as may be required.
10. All surface strikes shall be roller type and utilize a plate underneath to prevent movement.
11. Lever Trim: “Breakaway” design, forged brass or bronze escutcheon with a minimum of .130” thickness, match lockset lever design.
12. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key.
13. Furnish glass bead kits for vision lites where required.
14. All Exit Devices to be sex-bolted to the doors.
15. Panic Hardware shall comply with UBC Standard 10-4 and shall be mounted between 30” and 44” above the finished floor surface. The unlatching force shall not exceed 15 lbs. applied in the direction of travel. Panic hardware shall comply with CBC CBC Section 1003.3.1.9.

E. Closers: LCN as scheduled. Place closers inside building, stairs, room, etc.
1. Door closer cylinders shall be of high strength cast iron construction with double heat treated pinion shaft to provide low wear operating capabilities of internal parts throughout the life of the installation. All door closers shall be tested to ANSI/BHMA A156.4 test requirements by a BHMA certified testing laboratory.
2. All door closers shall be fully hydraulic and have full rack and pinion action with a shaft diameter of a minimum of 11/16 inch and piston diameter of 1.5 inch to ensure longevity and durability under all closer applications.
3. Closers shall be installed to permit doors to swing 180 degrees.
4. All closers shall utilize a stable fluid withstanding temperature range of 120 degrees F. to -30 degrees F. without requiring seasonal adjustment of closer speed to properly close the door.
5. Drop brackets are required at narrow head rails.
6. Maximum effort to operated doors shall not exceed 5 lbs., such pull or push effort being applied at right angles to hinged doors. Compensating devices or automatic door operators may be utilized to meet the above standards. When fire doors are required, the maximum effort to operate the door may be increased but shall not to exceed 15 lbs. When specifically approved by fire marshal. All closers shall be adjusted to operate with the minimum amount of opening force and still close and latch the door. Door shall take at least 3 seconds to move from an open position of 70 degrees to a point of 3 inches from the latch jamb. Reference CBC Sections 1133B.2.1, 1133B.2.5, 1133B2.5.1 & 1003.3.1.8.
7. Provide sex-bolted or through bolt mounting for all door closers.

F. Flush Bolts & Dust Proof Strikes: Automatic Flush Bolts shall be of the low operating force design. Utilize the top bolt only model for interior doors where applicable and as permitted by testing procedures.
1. Manual flush bolts only permitted on storage or mechanical openings as scheduled.
2. Provide dust proof strikes at openings using bottom bolts.

G. Coordinators:
1. Coordinator shall be a 1-5/8" wide by 5/8" high aluminum channel with the length variable to the door opening. It shall have a safety mechanism, which will allow the active door to close first if under extreme pressure.

H. Door Stops:
1. Unless otherwise noted in Hardware Sets, provide wall type with appropriate fasteners. Where wall type cannot be used, provide floor type. If neither can be used, provide overhead type.
2. Do not install floor stops more than four (4) inches from the face of the wall or partition (Title 24, 1133B.8.6).
3. Overhead stops shall be made of stainless steel and non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.

I. Protection Plates: Fabricate either kick, armor, or mop plates with four beveled edges. Provide kick plates 10" high and 2" LDW. Furnish with machine or wood screws of bronze or stainless to match other hardware.

J. Lock Protectors: Lock astragals shall be provided with internally threaded fasteners for flat head machine screws. No hex head or carriage bolt fasteners will be permitted. Must be through bolted to door.

K. Thresholds: As Scheduled and per details.
1. Thresholds shall not exceed 1/2" in height, with a beveled surface of 1:2 maximum slopes.
2. Set thresholds in a full bed of butyl rubber or polyisobutylene mastic sealant complying with requirements in Division 7 “Thermal and Moisture Protection”.
3. Use 1/4" fasteners, redheat flat head sleeve anchors (SS/FHSL).
4. Thresholds shall comply with CBC Section 1133B.2.4.1.

L. Seals: Sponge silicone gasketing to meet ASTM E 283-1984 test standards. Provide silicone gasket at all rated and exterior doors.

M. Door Shoes & Door Top Caps: Provide door shoes at all exterior wood doors and top caps at all exterior out-swing doors.

N. Silencers: Furnish silencers for interior hollow metal frames, 3 for single doors, 2 for pairs of doors. Omit where sound or light seals occurs, or for fire-resistive-rated door assemblies.

2.03 KEYING
A. Compatible to the existing keying system, furnish a Grand Master, Master keyed alike or keyed different system as directed by the Owner. Existing system is Schlage Quad with Primus.
B. Provide construction keying for doors requiring locking during construction; remove temporary cores or inserts immediately prior to Owner occupancy. Furnish permanent keys (and cores if applicable) directly to Owner.

C. Key Blanks: Standard 35-131 neutered bow stamped “Do Not Duplicate.”

D. Supply keys and blanks as follows:
   1. Supply 2 cut change keys for each different change key code.
   2. Supply 1 uncut key blank for each change key code.
   3. Supply 6 cut master keys for each different master key set.
   4. Supply 3 uncut key blanks for each master key set.

E. Cut keys to be stamped with key code name – not bitting.

2.04 FINISHES

A. Generally to be satin chromium US26D (626) unless otherwise noted.

B. Furnish push plates, pull plates and kick or armor plates in satin stainless steel US32D (630) unless otherwise noted.

C. Door closers shall be powder-coated to match other hardware, unless otherwise noted.

D. Aluminum items to be finished anodized aluminum US28 (628), except thresholds, which can be furnished as standard mill finish.

2.05 FASTENERS

A. Screws for strikes, face plates and similar items shall be flat head, countersunk type, provide machine screws for metal and standard wood screws for wood.

B. Screws for butt hinges shall be flathead, countersunk, full-thread type.

C. Fastening of closer bases or closer shoes to doors shall be by means of sex bolts and spray-painted to match closer finish.

D. Provide expansion anchors for attaching hardware items to concrete or masonry.

E. All exposed fasteners shall have a Phillips head.

F. Finish of exposed screws to match surface finish of hardware or other adjacent work.

G. All Exit Devices and Lock Protectors shall be fastened to the door by the means of sex bolts or through bolts.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that doors and frames are square and plumb and ready to receive work and dimensions are as instructed by the manufacturer.

B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and requirements of DHI.

B. Use the templates provided by hardware item manufacturer.

C. Mounting heights for hardware shall be as recommended by the Door and Hardware Institute. Operating hardware will to be located between 30” and 44” AFF. Per CBC Section 1133B.2.5.1.

D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

F. Set thresholds for exterior doors in full bed of butyl-rubber sealant.
G. If hand of door is changed during construction, make necessary changes in hardware at no additional cost.

3.03 ADJUST AND CLEAN
A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units, which cannot be adjusted to operate freely and smoothly as intended for the application made.
B. Clean adjacent surface soiled by hardware installation.
C. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.04 HARDWARE LOCATIONS
A. Conform to CCR, Title 24, Part 2, and ADAAG for positioning requirements for the handicapped.

3.05 FIELD QUALITY CONTROL
A. Architectural Hardware Consultant (AHC) to inspect installation and certify that hardware and its installation have been furnished and installed in accordance with manufacturer's instructions and as specified herein.

3.06 SCHEDULE
A. The items listed in the following schedule shall conform to the requirements of the foregoing specifications.

<table>
<thead>
<tr>
<th>Hardware Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Series Hardware Groups</td>
<td>Single Non-Electrical Doors</td>
</tr>
<tr>
<td>200 Series Hardware Groups</td>
<td>Pair Non-Electrical Doors</td>
</tr>
<tr>
<td>300 Series Hardware Groups</td>
<td>Single Electrical Doors</td>
</tr>
<tr>
<td>400 Series Hardware Groups</td>
<td>Pair Electrical Doors</td>
</tr>
<tr>
<td>500 Series Hardware Groups</td>
<td>Miscellaneous Doors (Sliding, Folding, Roll-UP, Misc.)</td>
</tr>
</tbody>
</table>

B. The Door Schedule on the Drawings indicates which hardware set is used with each door.

Manufacturers Abbreviations (Mfr.)

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADA</td>
<td>Adams Rite</td>
</tr>
<tr>
<td>B/O</td>
<td>By Others</td>
</tr>
<tr>
<td>GLY</td>
<td>Glynn-Johnson Corporation</td>
</tr>
<tr>
<td>IVE</td>
<td>Ives</td>
</tr>
<tr>
<td>LCN</td>
<td>LCN</td>
</tr>
<tr>
<td>LOC</td>
<td>Locknetics</td>
</tr>
<tr>
<td>MCK</td>
<td>McKinney</td>
</tr>
<tr>
<td>PEM</td>
<td>Pemko</td>
</tr>
<tr>
<td>RIX</td>
<td>Rixson</td>
</tr>
<tr>
<td>SCH</td>
<td>Schlage Lock Company</td>
</tr>
<tr>
<td>SEL</td>
<td>Select Products</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mfr.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Storefront Hardware</td>
<td>ADA</td>
</tr>
<tr>
<td>Miscellaneous Hardware</td>
<td>B/O</td>
</tr>
<tr>
<td>Overhead Door Stops</td>
<td>GLY</td>
</tr>
<tr>
<td>Hinges, Bolts, Coordinators, Dust Proof Strikes, Push, Pulls &amp; Protection Plates, Door Stops &amp; Silencers</td>
<td>IVE</td>
</tr>
<tr>
<td>Door Closers</td>
<td>LCN</td>
</tr>
<tr>
<td>Electro-magnets &amp; Power Supplies</td>
<td>LOC</td>
</tr>
<tr>
<td>Pivots</td>
<td>MCK</td>
</tr>
<tr>
<td>Thresholds, Gasketing &amp; Weather-stripping</td>
<td>PEM</td>
</tr>
<tr>
<td>Floor Closers &amp; Pivots</td>
<td>RIX</td>
</tr>
<tr>
<td>Locks, Latches &amp; Cylinders</td>
<td>SCH</td>
</tr>
<tr>
<td>Continuous Hinges</td>
<td>SEL</td>
</tr>
<tr>
<td>Hardware Group</td>
<td>Item Description</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>109</td>
<td>4 Ea Hinge</td>
</tr>
<tr>
<td></td>
<td>1 Ea Classroom Lock</td>
</tr>
<tr>
<td></td>
<td>1 Ea Core Only</td>
</tr>
<tr>
<td></td>
<td>1 Ea Dome Stop</td>
</tr>
<tr>
<td></td>
<td>Add Kick Plates @ Doors A312 &amp; A313</td>
</tr>
<tr>
<td>116</td>
<td>4 Ea Hinge</td>
</tr>
<tr>
<td></td>
<td>1 Ea Classroom Lock</td>
</tr>
<tr>
<td></td>
<td>1 Ea Core Only</td>
</tr>
<tr>
<td></td>
<td>1 Ea Surface Closer</td>
</tr>
<tr>
<td></td>
<td>1 Ea Kick Plate</td>
</tr>
<tr>
<td></td>
<td>1 Ea Overhead Stop</td>
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<td>316</td>
<td>4 Ea Hinge</td>
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<td>1 Ea Storeroom Lock</td>
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<td>1 Ea Electric Strike</td>
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<td>1 Ea Surface Closer</td>
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<tr>
<td></td>
<td>1 Ea Dome Stop</td>
</tr>
<tr>
<td></td>
<td>1 Ea Power Supply</td>
</tr>
</tbody>
</table>

Omit Power Supply at Door L342
Card Reader, Contact & Wiring By Elec /Security

END OF SECTION
SECTION 08800
GLASS AND GLAZING

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for interior glass and glazing.

B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Steel frames are specified in Section 08110.
   3. Interior aluminum door and glazing frames are specified in Section 08121.
   4. Flush wood doors are specified in Section 08212.

1.02 SUBMITTALS
A. General: Comply with Division 1.
B. Product Data: Manufacturer's technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions.
C. Qualification data for installer.

1.03 QUALITY ASSURANCE
A. Glazing Standards: Comply with recommendations of the following manufacturer and associations except where more stringent requirements are specified:

B. Safety Glass: Where safety glass is indicated or required, provide products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for category II materials. Permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that required for this Project, with a record of successful in-service performance.

D. Source Limitations: Obtain float glass from a single source from a single manufacturer for each glass type. Obtain glazing accessories from a single source from a single manufacturer for each product and installation method.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. Do not use products containing the following materials:
   1. Methylene Chloride or Chlorinated Hydrocarbons.
   2. Bactericides and fungicides that are classified as Phenol mercury acetates, phenol phenates, or phenol formaldehyde.
   3. Aromatic and aliphatic solvents.
   4. Styrene Butadiene.
B. Adhesives, sealants and primers applied to the building interior shall meet the VOC limits established in the South Coast Air Quality management District Rule #1168, July 1, 2005 and rule amendment date of January 7, 2007. (See Table 1 in Section 01352 LEED Requirements).

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1.

B. Protect glazing materials during delivery, storage, and handling; comply with manufacturer's directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture, temperature changes, direct exposure to sun and from other causes.

1.06 PROJECT CONDITIONS

A. Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing material manufacturer or when glazing channel substrates are wet.

B. Install glazing sealants at ambient and substrate temperatures above 40-deg. F.

PART 2 - PRODUCTS

2.01 GLASS PRODUCTS

A. Sizes: Fabricate glass to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer. Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as required to comply with Project conditions.

B. Manufacture heat-treated glass by horizontal (roller hearth) process with roll wave distortion parallel with bottom edge of glass as installed.

2.02 GLASS TYPES

A. Type 4: Clear tempered float glass complying with ASTM C1048, Condition A, Type I, Class 1, Quality q3, Kind FT; 1/4-inch thick.

B. Type 5: Clear tempered float glass complying with ASTM C1048, Condition A, Type I, Class 1, Quality q3, Kind FT; 1/2-inch thick.

C. Type 6: 1/2-inch thick clear tempered float glass with bands of clear and solid acid-etched areas. Refer to Interior Elevations for pattern.

2.03 ELASTOMERIC GLAZING SEALANTS

A. General: Comply with recommendations of sealant and glass manufacturer's for selection of glazing sealants with performance characteristics suitable for applications indicated and conditions at time of installation.

1. Compatibility: Select sealants with proven compatibility with other materials with which they will come into contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.

2. Suitability: Comply with recommendations of sealant and glass manufacturers for selection of glazing sealants which have performance characteristics suitable for applications indicated and conditions at time of installation.

3. VOC Content: For sealants used inside of the weatherproofing system, comply with requirements specified in Section 01352.

4. Colors: Color of exposed sealant as selected by Architect from manufacturer's standards.

B. Silicone Glazing Sealant: One-part elastomeric silicone sealant complying with ASTM C920, Type S, Grade NS, Class 100/50, Uses NT, G, A and 0 as applicable; Dow Corning 999, General Electric "SCS 1200", Rhone-Poulenc, Inc. "Rhodorsil 3B", Tremco "Proglaze" or approved equal.
C. Structural Silicone Glazing Sealant: One-part elastomeric silicone sealant complying with ASTM C920, Type S, Grade NS, Class 40, Uses T, NT, M, G, A, and 0 as applicable; Dow Corning 795, General Electric “Silpruf” or “Gesil”, Tremco, Inc. “Spectrum 2” or approved equal.

2.04 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100-percent, non-staining and non-migrating in contact with nonporous surfaces, with or without spacer rod as recommended by tape and glass manufacturers for application indicated, packaged in rolls with a release paper backing, complying with AAMA 800.

B. Expanded Cellular Glazing Tape: Closed-cell, polyvinyl chloride foam tape, factory coated with adhesive on both surfaces, packaged on rolls with release liner protecting adhesive, and complying with AAMA 800 for product 810.5.

2.05 GLAZING GASKETS

A. Dense Elastomeric Compression Seal Gaskets: Molded or extruded neoprene, EPDM, or silicone gaskets of profile and hardness required to maintain watertight seal; complying with ASTM C864, D.S. Brown Co., Maloney, Tremco or approved equal.

B. Soft Compression Gaskets: Extruded or molded closed cell, integral-skinned neoprene, EPDM, or silicone of profile and hardness required to maintain watertight seal; complying with ASTM C509, Type II, black; D.S. Brown Co., Maloney, Tremco or approved equal.

2.06 MISCELLANEOUS GLAZING MATERIALS

A. Compatibility: Provide materials with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.

C. Setting Blocks: Silicone blocks, 80 to 90 Shore A durometer hardness.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement.

F. Plastic Foam Joint Fillers: Prefomed, compressible, resilient, nonstaining, nonextruding, nonoutgassing, strips of closed-cell plastic foam of density, site, and shape to control sealant depth and otherwise contribute to produce optimum sealant performance.

2.07 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.

PART 3 - EXECUTION

3.01 INSPECTION

A. Inspect work for compliance with manufacturing and installation tolerances, including those for size, squareness, offsets at corners; existence of minimum required face or edge clearances; and for effective sealing of joinery. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean glazing channels and other framing members to receive glass. Remove coatings which are not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are to be used.

3.03 GLAZING, GENERAL
A. Comply with printed recommendations of glass, sealants, gaskets, and other glazing materials manufacturers.

B. Coordinate with framing system manufacturers for proper glazing channel dimensions to provide for necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with acceptable tolerances.

C. Protect glass from edge damage during handling and installation.
   1. Use a rolling block in rotating glass units to prevent damage to corners. Use suction cups to shift glass units within openings; do not raise of drift glass with a pry bar. Rotate glass with flares or bevels along one horizontal edge which would occur in vicinity of setting blocks so that these are located at top of opening.
   2. Remove and dispose of glass units with edge damage or other imperfections of a kind that would weaken glass when installed and impair performance and appearance.

D. Apply primers to joint surfaces where required for sealant adhesion.

E. Install setting blocks of proper size in sill rabbet, located to comply with referenced glazing standard. Set blocks in thin course of sealant.

F. Provide spacers inside and out, of size and spacing to preserve required face clearances for glass sizes larger than 50 united inches (length plus height), except where gaskets or glazing tapes with continuous spacer rods are used. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width, except with sealant tape use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking to comply with requirements of referenced glazing standard except where otherwise required by glass unit manufacturer.

H. Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.

I. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

J. Square cut wedge-shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.04 TAPE GLAZING

A. Position tapes on fixed stops so that when compressed by glass their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously but not in one continuous length. Do not stretch tapes to make them fit opening.

C. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each lite is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward center of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.
3.05 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.

B. Secure compression gaskets in place with joints located at corners to compress gaskets producing a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

C. Install gaskets so they protrude past face of glazing stops.

3.06 SEALANT GLAZING (WET)

A. Install continuous spacers between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized gaskets to protrude slightly out of channel to eliminate dirt and moisture pockets.

3.07 PROTECTION AND CLEANING

A. Protect glass from breakage. Do not apply markers to surfaces of glass. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances. Remove immediately by methods recommended by glass manufacturer.

C. Remove and replace glass which is broken, chipped, cracked, abraded or damaged during construction, including natural causes, accidents and vandalism.

D. Wash glass on both faces not more than 4-days prior to date scheduled for inspection for Substantial Completion. Use methods recommended by glass manufacturers.

3.08 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Close and seal tightly all partly used sealant containers and store protected in well ventilated fire-safe area at moderate temperatures.

C. Place used sealant tubes and containers in areas designated for hazardous materials.

END OF SECTION
SECTION 09110
NON-LOAD BEARING WALL FRAMING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section describes the requirements for furnishing and installing light-gauge non-load bearing wall framing systems, including metal studs, wall furring, and backing plates.

B. Related Sections:

1. Construction waste management is specified in Section 01505.
2. Acoustical joint sealants are specified in Section 07922.
3. Ceiling suspension systems are specified in Section 09120.
4. Acoustical suspension systems are specified in Section 09130.
5. Gypsum board is specified in Section 09250.
6. Acoustic insulation is specified in Section 09820.

1.02 DESIGN AND PERFORMANCE REQUIREMENTS

A. General: Where stud gauge and spacing is not indicated, engineer non-structural metal framing to comply with the following requirements.

1. Stud Systems: Select steel studs in accordance with manufacturer's standard load tables and the following deflection criteria, based on stud depth and spacing indicated and partition height required:
   a. Partitions to Receive Gypsum Board: L/240 unless otherwise indicated.
   b. Partitions to Receive Cabinets, Handrails, Grab Bars, Toilet Partitions or Accessories: L/360.
   d. Framed Ceilings: L/360.

B. Structural supports and blocking for light fixtures and miscellaneous wall- or ceiling-mounted items shall be designed and engineered by Contractor.

1.03 SUBMITTALS

A. General: Comply with the requirements specified in Division 1.

B. Product Data: Manufacturer's specifications and installation instructions for each type of metal support system, including provisions for fixture and equipment anchorage.

C. Shop Drawings: Show provision for fixture and equipment anchorage to stud systems different from typical systems or details indicated.

1.04 QUALITY ASSURANCE

A. Tolerances: Provide metal studs and furring installations that are plumb, true, straight, and rigid.

B. Welder's Qualifications: AWS D1.1 and 1.3 as applicable.

C. Fire-Test-Response Characteristics: Provide components that comply with rating requirements specified for fire-rated assemblies under UL 2079 for non-load bearing wall systems.

1. Deflection Clips and Firestop Track: Connections and/or top runner provided in fire-resistance-rated assemblies shall be certified by UL 2079 for cyclic movement requirements.
1.05 ENVIRONMENTAL QUALITY ASSURANCE
   A. Provide metal studs, runners, and furring channels with average recycled content of steel products such that
      post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 35-percent.

1.06 DELIVERY, STORAGE AND HANDLING
   A. General: Comply with the requirements specified in Division 1.
   B. Deliver products in the original unopened packages, containers, or bundles with manufacturer’s label intact and
      legible.
   C. Remove products delivered in broken, damaged, rusted or unlabeled condition from the Project site immediately.
   D. Protect products from rusting and other sources of damage.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS
   A. Angeles Metal Products, Clark Steel Framing Systems, Inc., Consolidated Systems, Inc., Dale/Incor Industries,
      Delta Metal Products, Dietrich Industries, Inc., Knorr Steel Framing Systems, The Steel Network Inc., Unimast,
      Inc., Western Metal or approved equal.

2.02 MATERIALS
   A. Metal Studs:
      1. Material: Mill-certified galvanized steel conforming to ASTM A653, G40 coating, minimum yield
         strength 33,000-psi.
      2. Construction: Formed C-channel section conforming to ASTM C645.
      3. Size and Thickness: As indicated or as required for specified deflection criteria, based on stud depth
         and spacing indicated and partition height required. If stud spacing is not indicated, space studs at 16-
         inches on center.
   B. Runner Tracks:
      1. Material: Mill-certified galvanized steel conforming to ASTM A653, G40 coating, minimum yield
         strength 33,000-psi.
      2. Construction: Formed channel section conforming to ASTM C645.
      3. Size: Minimum 1-inch flange width; web depth matching studs.
      4. Thickness: Same as studs.
   C. Vertical Deflection Connection: The Steel Network Inc. “VertiClip” or “VertiTrack”, FireTrak Corp “Shadowline”,
      Metal-Lite “Slotted Slip Track” or approved equal conforming to the following material properties and performance
      criteria:
      1. Code Criteria: Meet required head of wall connection criteria as required by CBC and as indicated in
         UL2079 for cyclic wall movement.
      2. Material Composition: ASTM A653, SS grade 50, class 1, 50-ksi minimum yield strength, 65-ksi
         minimum tensile strength, G60 hot dipped galvanized coating.
      3. Material Thickness: 0.036-inch.
4. Clips shall be designed for positive attachment to structure and stud web using step-bushing technology to provide frictionless vertical movement.

5. Provide clips with attached bushing and screw of the series, size, and configuration as recommended by manufacturer.

6. Top track devices pre-assembled to top track assembly in standard 12-foot lengths, with clips installed at spacing to coincide with stud spacing indicated may be used at Contractor’s option.

7. Friction-fit deep-leg track assemblies and tracks relying on steel flexure to perform are unacceptable.

D. Metal Channels: Mill-certified galvanized steel conforming to ASTM C653, G40 coating, minimum yield strength 33,000-psi.

1. Framing, Furring, and Stiffening:

<table>
<thead>
<tr>
<th>Size, Inches</th>
<th>Pounds per 1,000 Lineal Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 cold rolled</td>
<td>300</td>
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<tr>
<td>1-1/2 cold rolled</td>
<td>475</td>
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<tr>
<td>2 cold rolled</td>
<td>590</td>
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</table>

2. Furring Channels: Minimum 20-gauge galvanized steel with knurled faces; hat-shaped or Z-section as required.

E. Tie Wire: No. 16-gauge, galvanized, single-strand annealed steel or No. 18-gauge, galvanized, double-strand annealed steel.

F. Screws: ASTM C1002, Type S, pan head sheet metal screws, minimum 1/2-inch length.

G. Runner Track Fasteners: Tempered-steel pins with corrosive resistant plating or coating, 9/64-inch diameter, minimum 1-1/8-inch penetration, ICBO allowable shear value of 225-pounds.

H. Backing Plates: Provide backing plates as indicated.

I. Compression or Isolation Strips: Fiberglass, 1/2-inch nominal thickness, width equal to width of tracks or studs where used; density such that material will compress to one-half or less of loose thickness.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

A. Verify that conditions are satisfactory for the installation of metal support systems. Do not commence the installation until unsatisfactory conditions have been corrected.

B. Coordinate installation of metal support systems with the installers of other related work. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install non-load-bearing steel framing members in accordance with ASTM C754, and as specified.

B. Cutting:

1. General: Cut framing components squarely or on angle as required to fit tightly with proper bearing against abutting members.
2. Cutting Studs: If stud web is cut more than 50-percent, or stud flanges are cut, restore stud to original strength by wire-tying, or welding on steel reinforcement.

C. When studs extend to the underside of structural slabs, secure at top with a slip connection to accommodate slab deflection.

3.03 NON-LOAD-BEARING VERTICAL METAL FRAMING

A. Runner Tracks: Align at floor and ceiling with partition layouts. Secure to structure with specified fasteners located 2-inches from each end and spaced not to exceed 24-inches on center.

1. Coordinate installation of continuous isolation strips or acoustical sealant at acoustical partitions with installation of top and bottom runner tracks.

2. Where partition comes to underside of profile metal deck, create an acoustic seal to fill the profile. Use either metal plate or fiberglass and acoustic sealant, as indicated.

3. Notch runner tracks as required for curved partitions.

4. Where studs extend to structure above, provide vertical deflection accommodating devices where each stud connects to structural members above.

B. Installation of Metal Studs:

1. Install studs spaced 16-inches on center unless otherwise indicated. Screw-fasten framing connections using a minimum of 2 screws for each connection.

2. At partition corners and intersections, provide a minimum of 3 studs.

3. Splice studs where required, by nesting with a minimum lap of 8-inches; fasten laps with 2 screws through each flange.

4. Unless otherwise indicated, frame door openings with double 16-gauge vertical studs securely attached to each jamb of door frame.

   a. At head, install runner track; cut flanges at ends, bend web 90-degrees and screw attach to jamb studs.

   b. Install jack studs over door opening, spaced same as full-height studs.

   c. Where control joints extend upward from door jambs, install a jack stud spaced 1/2-inch from each jamb stud. Space next full-height stud not more than 6-inches from each jamb stud.

   d. Attach jamb studs to metal door frames with metal clips, each with 2 screws into jamb stud.

   e. Attach jamb studs to wood door frames with pairs of wood screws, spaced 24-inches on center.

5. Frame openings other than door openings in the same manner as for doors, and install framing below sills of openings to match framing required above door heads.

6. Frame both sides of expansion and control joints with a separate stud; do not bridge the joint with framing components.

7. Install continuous horizontal stiffeners in partitions where recommended by stud manufacturer for partition height, stud gauge, stud spacing, number of layers of gypsum board used, and anticipated stud deflection.

8. Stiffen openings with horizontal channels. Provide one channel continuous across head of openings extending to third stud beyond on each side. Provide one channel at each frame anchor extending to third stud beyond. Wire-tie or weld horizontal channels to each stud.
C. Chase-Wall Framing:
   1. Align two parallel rows of floor and ceiling runners according to partition layout.
   2. Position steel studs vertically in runners with flanges in same direction, with studs on opposite sides of chase directly across from each other. Anchor to runners in accordance with manufacturer’s instructions.
   3. Do not brace between stud rows in double-stud assemblies; laterally brace each stud row independently.

D. Wall Furring, Direct Attachment:
   1. Attach hat-shaped metal furring channels either vertically or horizontally. For furring positioned horizontally, attach a furring member not more than 4-inches from both the floor and ceiling. Secure with fasteners placed on alternate channel flanges, spaced on 16-inch centers.
   2. Attach Z-shaped metal channels vertically, spaced 16-inches on center unless otherwise indicated, with fasteners spaced 24-inches on center.

3.04 BACKING PLATES
   A. Install as indicated and specified for support of wall-hung cabinets, toilet partitions and accessories, and other items to be mounted on vertical surfaces.
   B. Welding shall comply with AWS D1.3.
   C. Paint welds with a rust-inhibitive paint.

3.05 HORIZONTAL FRAMED SURFACES
   A. Joist frame with studs of size, gauge and spacing indicated or as determined from manufacturer’s standard tables based on specified deflection criteria.
   B. Provide runner channels to receive studs at ceiling and walls of same gauge as studs. Secure with mechanical fasteners at 24-inches on center maximum.
   C. Secure studs to channels with screws.
   D. Provide furring channels in resilient sound isolation clips as indicated.

3.06 SOUND CONTROL WORK
   A. Specified requirements apply to framing for interior partitions indicated as sound partitions.
   B. Isolate top and bottom runners from direct contact with structure by installing over either:
      1. Continuous compression or isolation strips as specified, or
      2. Two continuous 1/4-inch beads of acoustical sealant specified in Section 07922 applied at quarter points of track width.
   C. Studs at terminal ends of partitions abutting intersecting walls or partitions, and studs that would otherwise contact intermediate structural columns shall be similarly installed over strips or sealant.

3.07 INSTALLATION TOLERANCES
   A. Variation from Plumb: Maximum 1/8-inch in 10-feet, non-cumulative and not greater than 1/16-inch per foot.
   B. Variation from Level: Maximum 1/8-inch in 10-feet, non-cumulative.
   C. Variation from True Plane: Maximum 1/8-inch in 10-feet, non-cumulative.
D. Variation from True Position: Maximum 1/4-inch, non-cumulative.
E. Variation of Member from Plane: Maximum 1/8-inch, non-cumulative.

3.08 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Separate and recycle waste materials to the maximum extent possible.

END OF SECTION
SECTION 09120
CEILING SUSPENSION SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing metal ceiling suspension systems, including suspended system for gypsum wallboard ceilings.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Acoustical suspension systems are specified in Section 09130.
   3. Gypsum board is specified in Section 09250.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer's specifications and installation instructions for each type of suspension system, including provisions for fixture and equipment anchorage.
   1. Include ICBO test reports showing proposed hanger and bracing wire fasteners are capable of supporting specified loads.

1.03 QUALITY ASSURANCE
A. Ceiling-support system shall limit deflection of finished ceilings to less than L/360.
B. Ceiling systems shall be designed and constructed in accordance with ASTM C635.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. Metal ceiling suspension system components shall have a minimum 50-percent recycled content.

1.05 DELIVERY, STORAGE, AND HANDLING
A. General: Comply with the requirements specified in Division 1.
B. Deliver products in the original unopened packages, containers, or bundles with manufacturer's label intact and legible.
C. Remove products delivered in broken, damaged, rusted, or unlabeled condition from Project site immediately.
D. Protect products from rusting and other sources of damage.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS
A. USG “Drywall Suspension System” or equal may be used in lieu of specified metal channel framing system at Contractor’s option.

2.02 MATERIALS
A. Metal Channels: ASTM C645, galvanized in accordance with ASTM A653, G60 coating designation.
1. Framing, Furring, and Stiffening:

<table>
<thead>
<tr>
<th>Size, Inches</th>
<th>Pounds per 1,000 Lineal Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 cold rolled</td>
<td>300</td>
</tr>
<tr>
<td>1-1/2 cold rolled</td>
<td>475</td>
</tr>
<tr>
<td>2 cold rolled</td>
<td>590</td>
</tr>
</tbody>
</table>

2. Furring Channels: Minimum 20-gauge galvanized steel with knurled faces; hat-shaped or Z-section as required.

B. Hanger Wire: Galvanized, soft, mild annealed steel; 8-gauge, unless otherwise indicated.

C. Diagonal Bracing Wire: Galvanized, soft, mild annealed steel; 12-gauge, unless otherwise indicated.

D. Tie Wire: No. 16-gauge, galvanized, single-strand annealed steel or No. 18-gauge, galvanized, double-strand annealed steel.

E. Screws:

1. General: ASTM C646, corrosion resistant, for attachment to metal framing 25-gauge and lighter; ASTM C954 for attachment to metal framing 20-gauge and heavier.

2. Thread and head designs and lengths as recommended by manufacturer for uses and materials involved.

F. Hanger and Bracing Wire Fasteners:

1. Hanger Wires: Connection device capable of carrying not less than 100-pounds.

2. Bracing Wires: Connection device capable of carrying not less than 200-pounds or the actual design load, whichever is greater, with a safety factor of 2 without yielding.

G. Furring Channel Clips: Fabricated from galvanized wire, for attaching furring channels to cold-rolled channels.

H. Compression Stiffeners: 20-gauge channel studs, 1-1/2-inches.

PART 3 - EXECUTION

3.01 SUSPENDED CEILING SUSPENSION FRAMING

A. Space 8-gauge hanger wires 48-inches on center along carrying channels and within 6-inches of ends of carrying channels.

B. Install 1-1/2-inch cold rolled carrying channels 48-inches on center and within 6-inches of walls. At splices, interlock flanges, overlap ends 12-inches, and wire-tie with double loops of No. 16-gauge wire.

C. Install 3/4-inch cold rolled channels at right angles to carrying channels, spaced 24-inches on center and within 6-inches of walls. Provide one-inch clearance between furring channels and abutting walls and partitions. Attach to carrying channels by saddle-tying around carrying channels with a minimum 8-inch overlap and wire-tie each end with double loops of No. 16-gauge wire.

D. Install 4-way 45-degree diagonal bracing wires at 12'-0" x 12'-0" within 6-inches of walls. Diagonal bracing wires shall be located at the intersection of main runner and cross-furring member. Provide connection between diagonal wires and main runner so as to prevent slipping for a 200-pound approximate seismic load.

E. Install hanger and bracing wire anchors so the direction of the wire aligns as closely as possible with the direction of the forces acting on the wire.

F. Separate ceiling hanging and bracing wires at least 6-inches from unbraced ducts, pipes, and conduit.
G. Fasten hanger wires with not less than 3 tight turns; fasten bracing wires with not less than 4 tight turns. Make all tight turns within a distance of 1-1/2-inches.

H. Install uplift stiffener for each 144-square feet of ceiling, consisting of a vertical metal stud occurring at the junction of the carrier and furring channel. Wire tie to carrier or screw to channel and secure to overhead structure.

I. At control joints, provide discontinuous lap in main runners occurring over joints. Do not bridge joints with cross furring where joints run perpendicular to furring. Where joints run parallel to furring, provide furring to support each side of joint.

J. Provide recesses and openings where indicated for lighting fixtures, registers, access panels, and other items to be installed in ceilings; provide additional furring channels where required by opening.

K. Recessed or drop-in light fixtures shall be supported directly by main runners or by supplemental framing which is supported by main runners.

L. Surface mounted fixtures shall be attached to a main runner with a positive clamping device made of material with a minimum of 14-gauge. Rotational spring catches are not acceptable.

3.02 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Separate and recycle waste materials to the maximum extent possible.

END OF SECTION
SECTION 09130
METAL ACOUSTICAL CEILING SUSPENSION SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for the materials and installation of acoustical suspension systems for acoustical panels.
B. Work under this Section includes furnishing and installing safety hanger wires for mechanical and electrical equipment to extent specified. Connecting safety wires to such equipment is not included.
C. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Ceiling suspension systems are specified in Section 09120.
   3. Acoustical panel ceilings are specified in Section 09511.
   4. Heating, ventilating and air conditioning work is specified in Division 15.
   5. Electrical work is specified in Division 16.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Shop Drawings:
   1. Indicate ceiling-system layouts and general and atypical conditions and details.
   2. Include details of bracing, special features and joints, perimeters, relationship to adjacent construction, and anchorage and connections to structures.
C. Product Data: Manufacturer's descriptive and technical data and illustrations, marked to identify product materials, types, and variations.
D. Material Samples: Duplicate sets of 10-inch-long pieces of grid system and perimeter trim members with one end as factory fabricated, and connection and fastening accessories and devices.

1.03 QUALITY ASSURANCE
A. Installer's Qualifications: Regularly providing installation of assemblies of the types required.
B. Suspension systems shall be designed, fabricated, and installed to meet requirements of ASTM C635.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. Provide acoustical suspension system components having a minimum of 50-percent combined pre-consumer/post-consumer recycled content.

PART 2 - PRODUCTS

2.01 EXPOSED NARROW FACE GRID SYSTEM
A. Approved Manufacturers: Armstrong “Suprafine XL HRC” or approved equal.
B. Material: Hot-dip galvanized steel made from USA produced recycled steel.
C. Main Runners: 9/16-inch flange, 1-11/16-inch high, double web construction.
D. Cross Runners: 9/16-inch flange, 1-11/16-inch high, double web construction.

E. Wall Angle, Reveals, and Miscellaneous Trim: Roll-formed from electrogalvanized steel strip to profiles indicated.

F. Ceiling Trim: Armstrong “Axiom Classic”, USG Interiors, Inc. “Compasso” or approved equal extruded aluminum trim. Heights as indicated, color to match grid system. Provide attachment clips, splice plates and diagonal braces as required for securing trim to grid.

G. Finish: Factory-applied white low gloss enamel.

H. Structural Classification: Heavy duty meeting the requirements of ASTM C635.

I. Provide USG, Inc. “Donn ACM7” or approved equal seismic clips for grid system connections to 7/8-inch wall angle.

J. Recycled Content:
   1. Total Content: 66-percent.
   2. Total Post-Consumer Content: 56-percent.

2.02 SUSPENSION MATERIALS AND FASTENINGS

A. General: Comply with requirements of ASTM C635.

B. Wire:
   1. General: ASTM A641, galvanized steel, regular coating, soft temper; factory pre-straightened units.

C. Wire Connections to Overhead Structures:
   1. Hanger Wires: Connection device capable of carrying not less than 100-pounds.
   2. Bracing Wires: Connection device capable of carrying not less than 200-pounds or the actual design load, whichever is greater, with a safety factor of 2 without yielding.

D. Fastenings for Accessories:
   1. Bolts or screws of adequate size, in types appropriate for conditions and materials involved, made of corrosion-resistant materials or coated as approved.
   2. Concealed only, unless otherwise indicated or approved.

E. Compression Stiffeners: Minimum 20-gauge metal stud with 7/8-inch flange up to 4-feet in length; minimum 25-gauge metal stud with 1-5/8-inch flange and lips up to 8-feet in length. Provide structural calculations for compression stiffeners greater than 8-feet in length.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. Installations shall be in accordance with manufacturers’ instructions and reviewed shop drawings, and ASTM C635.

B. Unless otherwise indicated, layout grid centered in both directions in each space, with edge panels not less than 1/2 width of full panel.
C. Anchor hanger and bracing wire anchors so that the direction of the wire aligns as closely as possible with the
direction of the forces acting on the wire.

D. Provide 12-gauge hanger wires at the ends of all main and cross runners within 8-inches from the support or
within 1/4 of the length of the end tee, whichever is least, for the perimeter of the ceiling area.

E. Provide trapeze or other supplementary support members at obstructions to main hanger spacing. Provide
additional hangers, struts or braces as required at all ceiling breaks, soffits or discontinuous areas. Hanger wires
more than 1 in 6 out of plumb shall have counter-sloping wires.

F. Ceiling grid members shall be attached to not more than 2 adjacent walls. Ceiling grid members shall be at least
1/2-inch free of other walls.

G. At the perimeter of the ceiling area where main or cross runners are not connected to the adjacent wall, provide
interconnection between the runners at the free end to prevent lateral spreading.

H. Provide sets of four 12-gauge splayed bracing wires oriented 90-degrees from each other at the following spaces:
   1. Place sets of bracing wires at a spacing not more than 12-feet by 12-feet on center.
   2. Provide bracing wires at locations not more than 1/2 the specified spacing from each perimeter wall
      and at the edge of vertical ceiling offsets.
   3. The slope of these wires shall not exceed 45-degrees from the plane of the ceiling and shall be taut
      without causing the ceiling to lift. Splices in bracing wires are not permitted.

I. Fasten hanger wires with not less than 3 tight turns; fasten bracing wires with 4 tight turns. Make tight turns
within a distance of 1-1/2-inches.

J. Testing of Concrete Anchors:
   1. When drilled-in concrete anchors or shot-in anchors are used in reinforced concrete for hanger wires, 1
      out of 10 shall be field tested for 200-pounds of tension.
   2. When drilled-in concrete anchors are used for bracing wires, 1 out of 2 shall be field tested for 440-
pounds in tension. Shot-in anchors in concrete are not permitted for bracing wires.

K. Support of Light Fixtures and Air Terminals:
   1. Ceiling suspension systems that support light fixtures, air-ventilation grilles or partitions shall have a
      classification of heavy-duty.
   2. Recessed or drop-in light fixtures and grilles shall be supported directly from the fixture housing to the
      structure above with a minimum of two 12-gauge wires located at diagonally opposite corners. Fixture
      support wires may be slightly loose to allow the fixture to seat in the grid system.
   3. Fixture shall not be supported from main runners or cross runners if the weight of the fixtures causes
      the total dead load to exceed the deflection capability of the ceiling suspension system.

L. Installation Tolerances:
   1. Bottom surface plane of each assembly shall be within plus or minus 1/8-inch of ceiling-height level
      required.
   2. Bottom surface plane of each assembly shall be level and true to plane within 1/8-inch in 12-feet.

3.02 PERIMETER TRIM

A. Provide in longest lengths available and combinations of lengths to minimize number of joints required.

B. Do not use pieces shorter than 48-inches.

C. Miter joints at corners.
D. Install to neatly close with adjoining vertical surfaces.

3.03 COMPLETION

A. Adjust hangers as required. Addition of kinks or bends in hanger are not acceptable; take up in ties only.

B. When complete, grid members of each assembly shall be mutually parallel/square, accurately aligned, with joints neatly formed and closely fitted and aligned flush; each assembly shall be securely anchored and braced to structure to prevent movement.

C. Exposed surfaces of grids shall be clean and free from scratches, dents, tool marks, stains, discoloration, fingerprints, and other defects and damage.

3.04 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Separate and recycle waste materials to the maximum extent possible.

END OF SECTION
SECTION 09250
GYPSUM BOARD

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing gypsum board and associated accessories.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Firestopping is specified in Section 07840.
   3. Acoustical joint sealants are specified in Section 07922.
   4. Non-load bearing wall framing is specified in Section 09110.
   5. Ceiling suspension systems are specified in Section 09120.
   6. Acoustic insulation is specified in Section 09820.
   7. Painting is specified in Section 09900.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer’s specifications and installation instructions for each type of gypsum wallboard and accessory required.
C. Layout Drawings: Furnish layout drawing showing proposed location of control joints.

1.03 QUALITY ASSURANCE
A. Manufacturer: Gypsum wallboard, including accessories and fasteners, shall be the products of the same manufacturer.
B. Gypsum wallboard work shall comply with ASTM C840 and CBC Section 2508 unless otherwise indicated or specified.
C. Installation and finishing of gypsum wallboard shall comply with GA-216. Installation of fire-rated gypsum board shall comply with their listing descriptions indicated on the Drawings.
D. Fire-Resistance Ratings: Where gypsum wallboard systems with fire-resistance ratings are indicated, provide materials and installations identical with those of applicable assemblies tested in accordance with ASTM E119 by fire testing laboratories acceptable to authorities having jurisdiction.
   1. Provide fire-resistance-rated assemblies identical to those indicated by reference to GA File No’s. in GA-600 “Fire Resistance Design Manual” or to design designations in UL “Fire Resistance Directory” or in listing of other testing and agencies acceptable to authorities having jurisdiction.
E. Allowable Tolerances:
   1. Gypsum wallboard surfaces shall have no measurable variation in any 2-foot direction and a maximum variation of 1/8-inch in 10-feet when a straightedge is laid on the surface in any direction. Specified tolerances apply to both plumbness of walls and levelness of ceilings.
   2. Shim work as required to comply with specified tolerances.
   3. Do not exceed 1/16-inch offset between planes of abutting sheets at edges or ends.
1.04 ENVIRONMENTAL QUALITY ASSURANCE

A. Adhesives and sealants applied to the building interior shall meet the VOC limits established in the South Coast Air Quality management District Rule #1168, July 1, 2005 and amendment date of January 7, 2007.


C. Provide gypsum board with a minimum of 100-percent combined pre-consumer/post-consumer recycled content.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with the requirements specified in Division 1.

B. Delivery:

1. Deliver materials to the Project site in original package containers or bundles with manufacturer's labels intact and legible.

2. Deliver fire-rated materials bearing the testing agency's label and classification identification.

C. Storage:

1. Store materials indoors in a dry area, under cover, and stacked flat off the floor.

2. Stack wallboard so that long lengths are not over short lengths.

D. Handle wallboard to avoid damaging face and edges of sheets.

E. Protect metal corner beads and trim from being bent or damaged.

1.06 PROJECT CONDITIONS

A. Establish and maintain environmental conditions for application and finishing gypsum board to comply with ASTM C840 and with gypsum board manufacturer's recommendations.

B. Minimum Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40-deg. F. For adhesive attachment and finishing of gypsum board, maintain not less than 50-deg. F. for 48-hours prior to application and continuously thereafter until drying is complete.

C. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials from drying too rapidly.

D. Provide for continuous ventilation during installation, using as close to 100-percent outside air as possible.

E. Protect workers and HVAC system from gypsum dust.

F. Remove and replace all gypsum board products that are exposed to water and display mold and mildew. Removal shall occur as soon as possible after exposure to water.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. United States Gypsum, CertainTeed Gypsum, Inc., Georgia Pacific, National Gypsum Company or approved equal.
2.02 GYPSUM BOARD

A. Gypsum Board: United States Gypsum “SHEETROCK SW” or equal with tapered rounded edge to minimize ridging or beading and other joint imperfections.
   1. ASTM C1396, regular type except where Type X fire-resistant type is indicated or required to meet UL assembly types.

B. Mold- and Moisture-Resistant Gypsum Board: United States Gypsum “SHEETROCK Mold Tough” or equal noncombustible, moisture- and mold-resistant gypsum core encased in moisture- and mold-resistant, 100-percent recycled face and back papers. Panels shall have a tapered long edge.
   1. ASTM C1396, regular type except where Type X fire-resistant type is indicated or required to meet UL assembly types.

2.03 GYPSUM BOARD ACCESSORIES

A. Screws: ASTM C954 or ASTM C1002.
   1. Use Type S screws for gypsum board attachment to light steel framing.
   2. Use Type S-12 screws for gypsum board attachment to 20-gauge and heavier steel framing.
   3. Use Type G screws for gypsum board attachment to gypsum board.

B. Metal Trim:
   1. Corner Bead: Steel, perforated-flange wing type, zinc coated in conformance with ASTM A653, G40 coating designation.
   2. Control Joint: Steel, perforated-flange wing type, with single bead, zinc coated in conformance with ASTM A653, G40 coating designation.
   3. Edge Trim: Steel, perforated-flange wing type, zinc coated in conformance with ASTM A653, G40 coating designation.
   4. Reveals: Pitcon "Softforms STR Series" or equal 1/2-inch reveal, finish as selected by the Architect.

   2. Joint Compound: All-purpose joint compound containing inert fillers and natural binders.
   3. Water-Resistant Joint Compound: Use special joint compound to treat joints and cut edges of moisture-resistant gypsum wallboard.


E. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59,
Subpart D (EPA Method 24).

F. Primer/Surfacer: United States Gypsum “SHEETROCK” Tuff-Hide primer-surfacer or approved equal.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that conditions are satisfactory for the installation of gypsum wallboard and accessories.
   1. Check framing for accurate spacing, alignment, plumbness, and levelness. Verify that both new and existing framing members will result in gypsum wallboard surfaces complying with specified tolerances.
   2. Verify spacing of installed framing does not exceed maximum allowable for thickness of wallboard to be used.
   3. Verify door frames are set for thickness of wallboard to be used.
   4. Repair protrusions of framing, twisted framing members, or unaligned members before installation of wallboard commences.

B. Do not commence the installation until unsatisfactory conditions have been corrected.

3.02 APPLICATION OF GYPSUM WALLBOARD

A. Apply materials in conformance with ASTM C840, the manufacturer’s instructions, and as indicated. Apply fire-rated materials in accordance with CBC Section 703.1.

B. When gypsum board is to be applied to both walls and ceilings, apply to ceilings first.

C. For partitions, apply full height sheets with long dimension parallel to framing members with abutting edges over supports. Where ceiling heights exceed 10'-0” and where required by fire resistive ratings, apply sheets with long dimension perpendicular to framing members. For ceilings, apply sheets with long dimension either perpendicular or parallel to framing members to result in fewest joints. For fire-rated assemblies, apply gypsum board in accordance with CBC Tables 720.1(2) and 720.1(3) as applicable.

D. Use sheets of maximum lengths to minimize end joints.

E. Neatly fit and stagger end joints.

F. Locate joints on different studs at opposite sides of partition.

G. Cut and fit neatly around outlets and switches. Back-to-back wall penetrations shall be at least two stud spaces apart for acoustic isolation.

H. Double-Layer Application:
   1. Apply base layer with long dimension perpendicular to and centered on framing; apply face layer parallel to framing. Apply base layer parallel to framing where required by fire-resistive ratings.
   2. Stagger sheets of each layer so that joints of each layer are 16-inches apart.

I. Isolation of Wallboard from Other Construction:
   1. Provide perimeter relief where wallboard abuts structural decks, ceilings, vertical structural elements, or window sections.
   2. Finish wallboard edge with corner bead.
   3. Seal space between casing bead and structure with continuous sealant bead.
   4. Seal around electrical boxes and conduit and pipe penetrations with acoustical sealant specified Section 07922.
5. Seal at base of wallboard sheets.

J. Acoustic Control Requirements for Sound Walls:
1. Leave a 1/8- to 1/4-inch space between gypsum wallboard and adjacent construction to provide a space for acoustical sealant.
2. Seal airtight with acoustical sealant material specified in Section 07922.
3. Seal penetrations through walls, or cuts in one face of walls, with a full bead of sealant at perimeter; this includes provisions for electrical outlet and switch boxes, pipes, ducts, and similar items.
4. Seal electrical boxes, including low voltage, at the back with specified sheet sealant pad. Where wires enter the boxes, seal the openings airtight around the wires and knockout openings.
5. Install mild steel sleeves where required, fiberglass packing between sleeve or framing, service and cover plates. Seal on both sides to render airtight.

K. Installation of Fasteners:
1. Do not locate fasteners less than 3/8-inch from edges or ends of sheets. Do not locate fasteners less than 1-inch from edges or ends in horizontal applications.
2. Fire-Rated Partitions: Install fasteners in accordance with the more restrictive of either CBC Table 720.1(2) or the Underwriters’ Laboratories assemblies as denoted on partition schedule.
4. Fire-Rated Ceilings: Install fasteners in accordance with CBC Table 720.1(3).
5. Non-Fire-Rated Ceilings: Install fasteners spaced not more than 12-inches on center.
6. Install screws using powered screw guns with adjustable screw-depth control head. Drive shank perpendicular to wallboard surface. Do not hammer screws.
7. Set fastener heads slightly below surface of wallboard, but do not break or strip paper face around fastener.
8. Stagger fasteners opposite each other on adjacent ends and edges.
9. Omit fasteners at edges where metal edge trim will be installed.

L. Installation of Accessories:
1. Install corner trim at vertical and horizontal external corners and angles, and edge trim at junctions of wallboard and other materials and at exposed edges.
2. Control Joints:
   a. Ceilings: Maximum area for ceilings with perimeter relief shall be 2,500-sq. ft.; maximum area for ceilings without perimeter relief shall be 900-sq. ft. Do not exceed 50-feet between control joints in ceilings with perimeter relief; 30-feet between control joints in ceilings without perimeter relief.
   b. Walls and Partitions: Maximum spacing between control joints shall not exceed 30-feet.
   c. Control joint locations shall occur only where indicated on reviewed layout drawings.

3.03 TAPING AND FINISHING
A. Finish Levels: Unless otherwise scheduled, required finish levels for various areas shall be as follows:

1. Level 0: In areas of temporary construction, no taping or accessories are required.
2. Level 1: In plenum areas above ceilings, attics, and other areas not normally exposed to view, joints and interior angles shall have tape embedded in joint compound. Surfaces shall be free of excess joint compound. Tool marks and ridges are acceptable.
3. Level 2: Not used.
4. Level 3: Not used.
5. Level 4: Typical unless otherwise indicated. Joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Joint compound shall be smooth and free of tool marks and ridges.
6. Level 5: On surfaces exposed to public view in the completed work, joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over joints, angles, fastener heads, and accessories. A thin skim coat of joint compound or material manufactured especially for this purpose, shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.

B. Mix joint finishing compounds in accordance with manufacturer's directions.

C. Joints:

1. Center tape over joint and embed in uniform layer of joint compound of sufficient width and depth to provide firm and complete bond. Apply skim coat while embedding tape.
   a. Treat angles with reinforcing tape folded to conform to adjacent surfaces and straight, true angles.
2. Apply finishing compound over taped joints. Apply number of coats specified for each finish level.
   a. Spread first coat evenly and feather out beyond joint center approximately 3-1/2-inches.
   b. After first coat is dry, sand or smooth to eliminate any high spots or excessive compound and cover with second coat with edges feathered out approximately 6-inches from center of joint. After second coat is dry, lightly sand with fine sandpaper or wipe with a damp sponge to leave a smooth even surface. When sanding, exercise caution not to raise nap of the gypsum board paper.
   c. Do not allow build-up at joints to exceed 1/16-inch.

D. Give dimples at fastener heads and marred spots on surface of wallboard one coat of joint compound and two coats of finishing compound, applied in same manner specified for joints.

E. Cut edges and openings around pipes and fixtures shall be caulked flush with sanitary sealant as specified in Section 07920.

F. Install metal accessories at external corners, exposed edges of gypsum board and where gypsum board abuts other materials.

1. Conceal flanges of metal accessories with a minimum of two coats of compound.
2. Extend compound 8- to 10-inches each side of accessories.
G. Primer/Surfacer: Complete gypsum board surface to Level 4 before applying primer-surfacer. Machine-apply with airless sprayer in conformance with manufacturer’s instructions to a wet film thickness of 15- to 20-mils. Allow to dry overnight before painting.

H. In the completed installation, wallboard shall have plumb and straight surfaces with no waves or buckles. Joints, fastener heads, and trim flanges shall be invisible after finishing. Surfaces shall be uniformly smooth and ready for painting or other decoration.

3.04 PROTECTION OF FINISHED WORK

A. Maintain temperature and humidity conditions as required to protect the installation.

B. Protect completed wallboard from damage or deterioration until final acceptance of the work.

3.05 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Separate clean waste gypsum products from contaminants for recycling. Do not include wood, plastic, metal, asphalt impregnated gypsum board or any gypsum board coated with glass fiber vinyl, decorative paper, paint or other finish. Place in designated area and protect from moisture and contamination.

C. Clean, unpainted waste gypsum products may be recycled by:

1. Returning to gypsum board manufacturer in lieu of landfill.

2. Hauling to alternative use manufacturer in lieu of landfill.

D. Separate metal waste and place in designated areas for recycling or reuse.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for the materials and installation of acoustical ceiling panels.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Acoustical suspension systems are specified in Section 09130.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer's descriptive and technical data and illustrations. Include MSDS data sheets.
C. Material Samples: Duplicate sets of full-size panels for each type and size of acoustical unit required.

1.03 EXTRA MATERIALS
A. In addition to acoustical panels for completing installations required, furnish additional units, in typical field sizes, for each type of unit used in the work.
B. Furnish quantities equal to not less than 3-percent of total installed area of each type of unit or greater to result in full carton lots for each type, except not less than one full carton for any one type of unit.
C. Supply extra units from production lots or color runs the same as for units used in the work, and supply in cartons as factory packaged and labeled. Also identify cartons with Project name and type of ceiling panel.
D. Deliver materials to project premises just prior to substantial completion, and store at location as directed.

PART 2 - PRODUCTS

2.01 ACOUSTICAL CEILING PANELS TYPE 1
A. Approved Manufacturers: Armstrong World Industries, Inc. “Dune” Item No. 1775 or approved equal.
B. Typical Field Size: Nominal 24- x 24-inches, 5/8-inch thick.
C. Edges: Beveled tegular.
D. NRC: 0.50.
E. CAC: 35.
F. Light Reflectance: 0.90.
G. Color: White.
H. Recycled Content:
   2. Pre-consumer Recycled Content: 28 - 42-percent.
I. VOC Formaldehyde: No added.
PART 2 - ACOUSTICAL CEILING PANELS TYPE 2

A. Approved Manufacturers: Armstrong World Industries, Inc. “Optima Plank” Item No. 3262 or approved equal.
B. Composition: Fiberglass.
C. Typical Field Size: Nominal 24- x 96-inches. Refer to drawings for custom sizes.
D. Edges: Square tegular.
E. NRC: 0.95.
F. AC: 190.
G. Light Reflectance: 0.90.

PART 3 - EXECUTION

3.01 AMBIENT CONDITIONS

A. Building shall have been entirely enclosed and heated not less than 10-days before start of suspended-ceiling work.
B. Before installation, acoustical units shall have been stored within the spaces where they are to be used for not less than 3-days, and with cartons opened and stripped sufficiently to permit units to stabilize to ambient conditions.
C. Remove and replace all acoustical panel ceiling products that are exposed to water and display mold and mildew. Removal shall occur as soon as possible after exposure to water.

3.02 INSTALLATION

A. Install acoustical panels in suspended grid system in accordance with manufacturer's instructions.
B. Field-cut edges of tegular edge acoustical panels shall be routed to match the edge profile of uncut panels so that panels lay in grid system flush with adjacent un-cut panels and edges of cut panels match the appearance of uncut panels.
C. Touch-up edges to match factory cut panels.

3.03 COMPLETION

A. Acoustical panels shall rest uniformly on their supporting members and shall be flat and free from twist and warp.
B. Exposed surfaces of acoustical units shall be clean and free from scratches, dents, tool marks, stains, discoloration, fingerprints, and other defects and damage.

3.04 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.
B. Separate waste and place in designated areas in the following categories for recycling:
   1. 1/2 panels and larger, set aside for reuse by Owner, non-profit organizations such as Habitat for Humanity, etc.
   2. Place scrap panels in designated areas for recycling or reuse.
   3. Separate cardboard waste and place in designated areas for recycling.
SECTION 09652
RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section includes the following:
   1. Resilient wall base.
   2. Resilient carpet accessories.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Carpet tile is specified in Section 09682.

1.02 SUBMITTALS
A. General: Comply with the requirements Division 1.
B. Product Data: Submit for each type of product specified.
C. Samples: Samples for verification purposes in manufacturer's standard sizes, but not less than 12-inches long, of each different color and pattern of product specified.

1.03 QUALITY ASSURANCE
A. Fire Performance Characteristics: Provide products with the following fire performance characteristics as determined by testing products per ASTM test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Critical Radiant Flux: 0.45-watts per sq. cm or more per ASTM E648.
   2. Smoke Density: Less than 450 per ASTM E662.
B. All materials shall comply with the requirements of Air Quality Management District (AQMD) Rule 1168 governing the emission of Volatile Organic Compounds.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. All adhesives and sealants applied to the building interior shall meet the VOC limits established in the South Coast Air Quality management District Rule #1168, July 1, 2005 and amendment date of January 7, 2007.
B. Resilient base and accessories shall be FloorScore certified.

1.05 DELIVERY, STORAGE, AND HANDLING
A. General: Comply with the requirements specified in Division 1.
B. Deliver products to Project site in original manufacturer's unopened cartons and containers, each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.
C. Store products in dry spaces protected from the weather with ambient temperatures maintained between 50- and 90-deg. F.
D. Move products into spaces where they will be installed at least 48-hours in advance of installation.
1.06 PROJECT CONDITIONS

A. Maintain a minimum temperature of 70-deg. F. in spaces to receive products specified in this Section for at least 48-hours prior to installation, during installation, and for not less than 48-hours after installation. After this period, maintain a temperature of not less than 55-deg. F.

B. Do not install products until they are at the same temperature as that of the space where they are to be installed.

C. Close spaces to traffic during installation of products specified in this Section.

D. Provide for continuous ventilation during installation using as close to 100-percent outside air as possible.

1.07 SEQUENCING AND SCHEDULING

A. Sequence installing products specified in this Section with other construction to minimize possibility of damage and soiling during remainder of construction period.

1.08 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.

1. Furnish not less than 10-linear feet for each 500-linear feet or fraction thereof of each different type and color of resilient wall base installed.

PART 2 - PRODUCTS

2.01 RESILIENT WALL BASE

A. Rubber Wall Base: Flexco or approved equal complying with ASTM F1861, Type TS or TP.

1. Style: Cove with top-set for use with hard surface flooring; straight with no toe for use with carpet.

2. Height: 4-inches.

3. Lengths: Coils in lengths standard with manufacturer but not less than 100-feet.


5. Interior Corners: Premolded.


2.02 RUBBER ACCESSORIES

A. Provide rubber carpet edge for glue down applications.

B. Profile and Dimensions: As indicated.

C. Color: 071 Black/Brown.

2.03 INSTALLATION ACCESSORIES

A. Concrete Slab Primer: Non-staining type as recommended by flooring manufacturer.

B. Trowelable Underlayments and Patching Compounds: Latex-modified, portland-cement-based formulation provided or approved by flooring manufacturer for applications indicated.
C. Adhesives: Provide type and brands of solvent free water-resistant adhesive as recommended by manufacturer of resilient wall base and accessories for conditions of installation.

1. VOC Content: Comply with the following limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Resilient Base Adhesives: Not more than 50 g/L.

PART 3 - EXECUTION

3.01 PREPARATION

A. Comply with manufacturer's installation specifications for preparing substrates indicated to receive products indicated.

B. Use trowelable leveling and patching compounds per manufacturers directions to fill cracks, holes, and depressions in substrates.

C. Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.

D. Broom or vacuum clean substrates to be covered immediately before installing products specified in this Section. Following cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.

E. Apply concrete slab primer, if recommended by flooring manufacturer, prior to applying adhesive. Apply according to manufacturer's directions.

3.02 INSTALLATION

A. Install products specified in this Section using methods indicated according to manufacturer's installation directions.

B. Apply resilient wall base to walls, columns, pilasters, casework, and other permanent fixtures in rooms and areas where base is required. Install wall base in lengths as long as practicable. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
   1. Install inside and exterior corners before installing straight pieces.

C. Place resilient accessories so they are butted to adjacent materials of type indicated and bond to substrates with adhesive. Install reducer strips at edges of flooring that otherwise would be exposed.

3.03 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing installation:
   1. Remove visible adhesive and other surface blemishes using cleaner recommended by manufacturers of resilient product involved.
   2. Sweep or vacuum floor thoroughly.
   3. Do not wash floor until after time period recommended by manufacturer.
   4. Damp-mop resilient accessories to remove black marks and soil.

B. Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended by manufacturer of resilient product involved.

C. Clean products specified in this Section not more than 4 days prior to dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean products using method recommended by manufacturer.
3.04 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Close and seal tightly all partly used adhesive containers and store protected in well ventilated fire-safe area at moderate temperatures.

C. Place used adhesive tubes and containers in areas designated for hazardous materials.

END OF SECTION
SECTION 09682
CARPET TILE

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for installing carpet tile and accessories.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Resilient base and accessories are specified in Section 09652.
   3. Access flooring is specified in Section 10270.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer’s product literature and installation instructions for each type of carpet tile and accessory required. Include data on physical characteristics, durability, resistance to fading and flame resistance characteristics.
C. Layout and Seaming Diagrams: Show layout and seaming diagrams indicating carpet tile direction, types of edge strips, columns, doorways, enclosing walls or partitions, built-in cabinets, and locations of cutouts. Include installation details at special conditions.
D. Samples for Verification Purposes: Full size samples of each carpet tile, 12-inch long samples of each type of exposed edge stripping.
E. Warranty.

1.03 QUALITY ASSURANCE
A. Carpet Tile Surface Burning Characteristics: Provide carpet identical to that tested for the following fire performance characteristics, per test method specified below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify carpet with appropriate markings of applicable testing and inspecting organization.
   1. Test Method: DOC FF 1-70.
   2. Test Method: ASTM E84.
      a. Flame Spread: 25 or less.
      b. Smoke Developed: 450 or less.
B. Installer’s Qualifications: Minimum 2-years experience in installation of commercial carpet tile of type, quantity and installation methods similar to work of this Section.
C. All materials shall comply with the requirements of Air Quality Management District (AQMD) Rule 1168 governing the emission of Volatile Organic Compounds.

1.04 ENVIRONMENTAL QUALITY ASSURANCE

A. Provide carpet tile that complies with testing and product requirements of Carpet and Rug Institute’s “Green Label Plus” program.

B. Carpet adhesive shall not exceed the VOC limit of 50 g/L.

C. Provide carpet tile having a minimum of 40-percent combined pre-consumer/post-consumer recycled content.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with the requirements specified in Division 1.

B. Deliver carpet tile in original factory protective wrapping and containers, labeled with identification of manufacturer, brand name, quality or grade, fire hazard classification, and lot number.

C. Store inside, in well-ventilated area, protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.06 COORDINATION

A. Prior to construction of each type of new substrate which is to support carpet tile, furnish information on substrate texture and condition required for each type of carpet tile.

B. Painting work in areas to receive carpet tile shall be completed prior to installation of carpet tile.

C. Carpet tile shall be unpackaged, inspected, and stored in a well-ventilated area off site for a minimum of 72-hours prior to delivery to the Project site.

1.07 PROJECT CONDITIONS

A. Use adhesives in strict accordance with manufacturer’s recommendations and ventilate area with maximum outside air for a period of not less than 48-hours after completion.

1.08 WARRANTY

A. Warrant the surface pile against abrasive wear of more than 10-percent within 10-years for carpet tile as properly installed and maintained. Misuse, damage, or improper cleaning methods shall not apply.

B. Warrant installation against stretching, wrinkling, opening of joints, and other areas of poor materials and workmanship for a period of 2-years after final acceptance of Project. Provide materials and labor necessary for repair or replacement, without additional cost to the Owner.

C. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.
1.09 MAINTENANCE

A. Maintenance Instructions: Furnish manufacturer's printed instructions for maintenance of installed carpet tile, including methods and frequency recommended for maintaining. Include precautions against materials and methods that may be detrimental to finishes and performance.

B. Replacement Materials: Prior to installation of carpet tile, deliver in full boxes not less than 2-percent of each type, color, and pattern of carpet tile, exclusive of material required to properly complete installation. Furnish accessory components as required. Replacement materials shall be from the same production run as materials installed. Package with protective covering, identified with appropriate labels. Installation scraps and trimmed pieces will not be acceptable.

PART 2 - PRODUCTS

2.01 TILE CARPETING

A. General: Carpet substitutions shall match all characteristics of the specified carpet.

B. Carpet CA-1A, -1B:

1. Approved Manufacturer: Prince Street "Animal Talk", style #160230AB0A or equal.
5. Fiber: DuPont Antron Lumena solution dyed nylon.
7. Soil Protection: DuPont DuraTech Soil Resistant Treatment.
12. Weight Density: 121,368.
13. Total Weight: 120-oz./sq. yd.
14. Total Thickness: 0.345-inch.
15. Pattern Repeat: None.
C. Carpet CA-2:

1. Approved Manufacturer: Bentley Prince Street City Planning, 408088 City Guide, (Light Color)
   a. City Planning   NexStep® Cushion Tile
   b. Product Number: 4C0300AB0A
   c. Product Construction: Tufted Textured Loop
   d. Color: City Guided #408088
   e. Yarn System: Antron® Brilliance™ of nylon
   f. Dye Method: Piece Dye
   g. Soil/Stain protection: Protekt®
   h. Antimicrobial: Intersept®

2. Product Specifications
   a. Tufted Yarn Weight: 30oz/yd²
   b. Machine Gauge: 1/12in
   c. Pile Height:
      1). High: 0.246in
      2). Medium: 0.166in
      3). Low: 0.08in
   d. Stitches: 10.8in
   e. Pile Density: 6585
   f. Total Thickness: 0.389in
   g. Size: 19.69in x 39.38in
   h. Pattern Repeat: None

3. Performance Specifications
   a. Radiant panel: Passes Class 1 (ASTM E - 648) Critical Radiant Flux > 0.45 W/cm² – Direct Glue
   b. Smoke Density: Dm corrected ≤ 450 (ASTM E - 662)
   c. Static: (AATCC 134) < 3.5 KV
2.02 ACCESSORY MATERIALS

A. Carpet Tile Adhesive: Water-resistant, non-staining type as recommended by carpet tile manufacturer, complying with flammability requirements for installed carpet.

1. VOC Content: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 PREPARATION

A. Clear away debris and scrape up cementitious deposits from concrete surfaces to receive carpet tile; apply sealer to prevent dusting.

B. Patch holes and level to a smooth surface. If previous finish was chemically stripped, reseal concrete. Seal powdery or porous surfaces with sealer recommended by carpet tile manufacturer.

C. Patch holes and cracks. Sand to level. Remove wax. Seal surface with sealer recommended by carpet tile manufacturer.

3.02 INSTALLATION

A. Apply carpet tiles to access flooring panels in accordance with manufacturer's instructions.

B. Install carpet tiles in accordance with the recommendations contained in the Carpet and Rug Institute (CRI) "CRI Carpet Installation Standard 2011"

C. Cement carpet tiles directly to access floor panels. Remove excess cement with approved solvent.

D. Cut evenly along panel edges, cut and fit evenly around projections, corners, electrical outlets, floor air or heating elements, and trim strips.

E. Securely fasten carpet edging strips to floor wherever carpet tiles meet different floor material and no threshold or other divider is noted.

F. Extend carpet tile materials under all open-bottomed and raised-bottom obstructions, and under removable flanges of obstructions. Extend carpet tiles into closets and alcoves of rooms indicated to receive carpeting, unless another material is specifically identified to be used in that space. Carpet tile shall be installed under all movable furniture and equipment.

G. Finish installation shall be free from visual defects.

H. The Owner may review carpet tile scraps and retain any he chooses. Remove remainder of scraps from site.

I. Leave carpet base and walls clean and free from stains, blemishes and other foreign material. Remove loose threads and vacuum clean.

J. Installation shall not receive furniture or heavy traffic for 48-hours after installation.
3.03 CLEAN UP

A. After completion of the carpet tile installation, remove all waste and excess materials, tools and equipment. The complete installation shall be thoroughly vacuumed, using an upright, commercial grade, beater type cleaner, and left in a clean condition. Provide all necessary temporary protection required.

3.04 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. All scraps of unused material shall be reclaimed and recycled by the carpet tile manufacturer. Include a detailed confirmation of the material received by the manufacturer and documentation that these materials have been recycled into new flooring materials. No incineration of reclaimed materials is acceptable.

END OF SECTION
SECTION 09810
ACOUSTIC INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing acoustic insulation.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Firestopping insulation is specified in Section 07840.
   3. Acoustical joint sealants are specified in Section 07922.
   4. Acoustical suspension systems are specified in Section 09130.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer's specifications for each type of insulation required.

1.03 QUALITY ASSURANCE
A. Fire Ratings: Comply with fire-resistance and flammability ratings specified.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. Adhesives, sealants and sealant primers shall not exceed the VOC limits established in South Coast Air Quality Management District Rule 1168, effective date of July 1, 2005 and rule amendment date of January 7, 2007.
B. Provide acoustical blankets with a minimum of 25-percent recycled content.

1.05 DELIVERY, STORAGE, AND HANDLING
A. General: Comply with the requirements specified in Division 1.
B. Protect insulation from physical damage and from becoming wet or soiled. Comply with manufacturer's recommendations for handling, storage and protection during installation.

1.06 INDOOR AIR QUALITY
A. Protect ducts and HVAC system from loose insulation particulates.
B. Provide temporary ventilation of building areas where building insulation is being installed.

PART 2 - PRODUCTS

2.01 ACOUSTIC INSULATION
A. Formaldehyde-free Unfaced Glass Fiber Blanket/Batt Acoustical Insulation: Acoustical insulation produced by combining glass fibers with formaldehyde-free thermosetting resins to comply with ASTM C665, Type I.
   1. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 25 and 50 when tested in accordance with ASTM E84.
3. Thickness: 3-inches unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's instructions for installation conditions.

B. Do not install insulation until building is sufficiently enclosed or protected against absorption of moisture by the insulation, and do not install insulation unless supporting framing and construction is in a thoroughly dry condition.

C. Install snugly between framing members with ends snugly fitted between units and against adjacent construction.

D. Carefully cut and fit insulation around pipes, conduit, and other obstructions and penetrations.

E. Where door and window frames occur in framing, cut additional strips of insulation and hand-pack as required to fill voids in and around such frames.

3.02 PROTECTION

A. Protect installed insulation from harmful exposures and from physical damage.

3.03 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Plan and coordinate the insulation work to minimize the generation of offcuts and waste. Remove insulation scraps to the maximum extent feasible.

C. Separate and recycle waste materials to the maximum extent possible.

END OF SECTION
SECTION 09845

FABRIC-WRAPPED PANELS

PART 1 - GENERAL

1.01 DESCRIPTION
   A. This Section includes fabric-wrapped panels including mounting hardware, fasteners and accessories as required for a complete installation.
   B. Related Sections:
      1. Construction waste management is specified in Section 01505.

1.02 SUBMITTALS
   A. General: Comply with Division 1.
   B. Product Data: Furnish product data for each type of fabric-wrapped wall panel.
   C. Samples for Verification Purposes: 24-inch square panels with selected fabric and finished edges. Include representative samples of installation devices and accessories.
   D. Layout Drawings: Elevations of walls to receive fabric-wrapped panels showing layout and joint pattern dimensions and details of attachment.

1.03 QUALITY ASSURANCE
   A. Fire-Test-Response Characteristics: Provide fabric-wrapped wall panels with surface-burning characteristics as specified, determined by testing assembled materials composed of facings and backings identical to those required for this Section, in accordance with ASTM E84, by a testing organization acceptable to authorities having jurisdiction.
      1. Flame Spread: 25 or less.
      2. Smoke Developed: 450 or less.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. General: Comply with Division 1.
   B. Protect fabric-wrapped wall panels from excessive moisture in shipment, storage, and handling. Deliver in unopened bundles and store in a dry place with adequate air circulation. Do not deliver material to building until "wet work" such as concrete and plaster have been completed and cured to a condition of equilibrium.

1.05 PROJECT CONDITIONS
   A. Environmental Conditions: Do not begin installation until spaces to receive fabric-wrapped wall panels have been enclosed and maintained at approximately the same humidity and temperature conditions as planned for occupancy. Maintain temperature and humidity as recommended by panel manufacturer.
   B. Field Measurements: Check wall surfaces by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay in work.

PART 2 - PRODUCTS

2.01 FABRIC-WRAPPED PANELS
   A. Approved Manufacturers: Wall Technology, Inc., Capaul Corp., Conwed Designscape, Decoustics Ltd. or equal.
   B. Construction: Facing material stretched over edge-framed, glass fiberboard core and bonded or attached to
edges and back of frame.

C. NRC: 0.85 or better.

D. Core: Fiberglass with chemically hardened edges to resist edge damage, minimum 7-pcf density. Provide tackable core material where tackable panels are indicated. Wrap fabric at edges to provide trimless edges.

E. Facing Material: Maharam, Mettle 398230, 103 Sesame 2 color.

F. Edge and Corner Detail: Square.

G. Panel Fabrication: Fabricate panels to sizes and configurations indicated; attach facing materials to cores to produce installed panels with visible surfaces fully covered and free from wrinkles, sags, blisters, seams, adhesive or other foreign matter. Overall height and width dimensional tolerances of finished units shall be plus or minus 1/16-inch.

H. Mounting Accessories: Z-clip hanger and magnet system with magnets recessed into the frame and designed to engage steel mounting plates secured to the wall with leveling mastic.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panels with vertical surfaces and edges plumb, top edges level and in alignment with other panels, scribed to fit adjoining work accurately at borders and penetrations.

B. Comply with panel manufacturer's printed instructions.

C. Tolerances:
   1. Variation from Plumb and Level: Plus or minus 1/16-inch.
   2. Variation of Joints from Hairline: Not more than 1/16-inch.

3.02 COMPLETION

A. Clean soiled or discolored surfaces after installation.

B. Remove and replace damaged or improperly installed fabric-covered panels and replace with new as directed by the Architect.

3.03 PROTECTION

A. Provide final protection and maintain conditions to ensure that panels are without damage or deterioration at time of Substantial Completion.

B. Replace panels that cannot be cleaned and repaired, as acceptable to the Architect.

3.04 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Plan and coordinate the insulation work to minimize the generation of offcuts and waste. Remove insulation scraps to the maximum extent feasible.

C. Separate and recycle waste materials to the maximum extent possible.

END OF SECTION
SECTION 09900
PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section describes the requirements for painting and finishing of interior exposed items and surfaces.

1. Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatments specified in other Sections.

2. Work includes painting exposed pipes and ducts, hangers, exposed steel and iron, and primed metal surfaces of Mechanical and Electrical equipment, and general sheet metal work, except as otherwise indicated or specified.

3. Work includes painting hardware specified as primed (USP or 600).

4. Work includes sanding shop-primed surfaces and applying specified primer and finish coats.

5. "Paint" means coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

B. Surfaces Not to Be Painted:

1. Pre-finished items, including but not limited to acoustic materials, casework, and finished mechanical and electrical equipment, including light fixtures, switchgear and distribution cabinets.

2. Concealed surfaces such as walls or ceilings in concealed areas and inaccessible areas, furred areas, pipe spaces, and duct shafts.

3. Finished metal surfaces such as anodized aluminum, stainless steel, chromium plate, copper, bronze and similar finished materials, exterior aluminum entrances, storefronts, and windows.

4. Moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts.

5. Other indicated and specified items not to receive an applied finish.

C. Following categories of work are included under other Sections:

1. Shop priming ferrous metal items including structural steel, metal fabrications, hollow metal work and similar items. The work of this Section includes sanding and applying specified primer on all shop-primed surfaces exposed to view in the completed work.

2. Shop priming of fabricated components such as architectural woodwork, wood casework and shop-fabricated or factory-built mechanical and electrical equipment or accessories.

3. Piping identification is specified in Division 15.

D. Do not paint over code-required labels, equipment identification, performance rating, name, or nomenclature plates.

E. Related Sections:

1. Construction waste management is specified in Section 01505.

1.02 SUBMITTALS

A. General: Comply with Division 1.

B. Certification: Furnish certification by the paint manufacturer that products supplied comply with local regulations.
controlling the use of volatile organic compounds (VOCs).

C. Samples: Furnish samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture is achieved.

2. Furnish samples on the following substrates for review of color and texture only:
   a. Painted Wood: Two 12-inch square samples of each color and material on hardboard.
   b. Stained or Natural Wood: Two 4-inch x 8-inch samples of natural and stained wood finish on actual wood samples.

D. Product Data: Specified paint systems are those of Benjamin Moore. If other paint manufacturers are proposed and accepted by the Owner’s Representative, furnish product comparison charts showing that proposed paint systems are equal to the specified materials in number of coats, type of paint, and sheen.

1.03 QUALITY ASSURANCE

A. Applicators Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent.

B. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use thinners approved by paint manufacturer, and use within recommended limits.

C. Coordination of Work: Review other Sections in which prime paints are to be provided to ensure compatibility of coatings system for various substrates. Upon request, furnish information or characteristics of finish materials to be used.

D. Requirements of Regulatory Agencies: Comply with applicable rules and regulations of governing agencies for air quality control.

1. Comply with current applicable regulations of the local air quality district, California Air Resources Board (CARB) and the Environmental Protection Agency (EPA).

2. Regulatory changes may affect the formulation, availability, or use of specified coatings. Confirm availability of coatings to be used prior to start of painting.

E. Field Samples: On interior wall surfaces provide full-coat finish samples on at least 100-sq. ft. of surface, as directed, until required sheen, color and texture is obtained; simulate finished lighting conditions for review of in-place work. Approved samples will be used as a standard for the Project.

1.04 INTERIOR ENVIRONMENTAL QUALITY ASSURANCE


1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1.

B. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name, batch number, color, and directions.
C. Store materials in tightly covered containers. Maintain containers in a clean condition, free of foreign materials and residue.

D. Keep storage area neat and orderly. Remove oily rags and waste daily. Ensure that workers and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.06 JOB CONDITIONS

A. Apply water-base paints when temperature of surfaces to be painted and surrounding air temperatures are between 50-deg. F. and 90-deg. F., unless otherwise permitted by paint manufacturer's printed instructions.

B. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45-deg. F. and 90-deg. F., unless otherwise permitted by paint manufacturer's printed instructions.

C. Do not apply paint in rain, fog or mist, when relative humidity exceeds 85-percent, or when temperature is less than 5-deg. F. above dew point, or to damp or wet surfaces, unless otherwise permitted by paint manufacturer's printed instructions.

D. Provide adequate ventilation during interior painting using as close to 100-percent outside air as possible.

1.07 EXTRA MATERIALS

A. In addition to materials for completion of the work, furnish 5-gallons of additional materials for each type and color of opaque paint used.

B. Furnish extra materials from same production lots or color runs used in the work. Furnish in containers factory sealed and labeled. Identify each container with Project name and type of material.

C. Deliver materials and an inventory list just prior to Substantial Completion and store where directed by Architect.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. ICI Paints or approved equal.

2.02 MATERIALS

A. Material Compatibility: Provide block fillers, primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application.

B. Material Quality: Provide best quality grade of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable. Each product within any one paint system shall be from the same manufacturer.

2.03 COLORS AND SHEENS

A. PT1: Match Benjamin Moore, Color Preview, Color: White, eggshell sheen.

B. PT2: Match Benjamin Moore, Color Preview, Color: White, flat sheen.


D. PT7: Match Sherwin Williams, Color: SW0044, Hubbard Squash, LRV 60%, eggshell sheen.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions under which painting is to be applied. Surfaces receiving paint shall be thoroughly dry before paint is applied.

1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect prior to applying barrier coats.

2. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning.

3. Start of painting will be construed as the applicator’s acceptance of surfaces and conditions within a particular area.

3.02 PROTECTION

A. Protection: Protect work of other Sections against damage by painting and finishing work. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.

1. Provide “Wet Paint” signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.

2. Remove or protect hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting. Following completion of painting, reinstall removed items.

3. At completion of work of other Sections, touch-up and restore damaged or defaced painted surfaces.

3.03 SURFACE PREPARATION

A. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

1. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dry.

2. Prime, stain, or seal wood to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling.

3. When transparent finish is required, back-prime with spar varnish.

4. Back-prime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.

5. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately upon delivery.

B. Ferrous Metal: Clean ungalvanized ferrous metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of The Society for Protective Coatings (SSPC).

1. Blast surfaces clean as recommended by the paint system manufacturer and according to requirements of SSPC specification SSPC-SP 10.

2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

3. Sand shop-applied prime coats to a smooth surface, ready to receive specified primer and finish coats.
C. Galvanized Metals: Clean with non-petroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Gypsum Board: Clean surfaces of dust, dirt, grease, oil and other foreign matter and dust clean.

E. Existing Surfaces to be Repainted: Thoroughly clean and de-gloss surfaces to be repainted by sanding or other means prior to painting. Patched and bare areas shall be shop-primed with same alkyd primer as specified for new work.

3.04 MATERIALS PREPARATION

A. Mix and prepare painting materials in accordance with manufacturer’s directions.

B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and strain material before using.

D. Use thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.05 APPLICATION

A. General: Apply paint in accordance with manufacturer’s directions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Provide finish coats compatible with prime coats.

2. The number of coats required is the same regardless of the application method. Do not apply following coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where required to produce a smooth even surface.

3. Apply additional coats when undercoats, stains or other conditions show through final coat, until paint film is of uniform finish, color and appearance. Edges, corners, crevices, welds, and exposed fasteners shall receive a dry film thickness equivalent to that of flat surfaces.

4. Paint surfaces behind movable equipment and furniture.

5. Paint surfaces behind permanently-fixed equipment or furniture with prime coat before final installation of equipment.

6. Paint visible surfaces of ducts where visible through registers or grilles with a flat, non-specular black paint.

7. Paint back sides of access panels, and removable or hinged covers to match exposed surfaces.

8. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.

9. Finish doors on top, bottom and side edges same as faces. Where openings into rooms have different finishes, finish door edges as directed by the Architect.

10. Omit primer on metal surfaces that have been shop-primed and touch-up painted, unless otherwise indicated.

B. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation.

1. Allow sufficient time between successive coatings to permit proper drying.
C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's instructions.
   1. Brushes: Use brushes best suited for the material applied.
   2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
   3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate.

E. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces. Finish to match adjoining wall or ceiling surfaces.
   1. Mechanical items to be painted include, but are not limited to, piping, hangers, and supports; heat exchangers; tanks; ductwork; insulation; supports; motors and mechanical equipment; air grilles and diffusers; and accessory items.
   2. Electrical items to be painted include, but are not limited to conduit and fittings, panels, and switchgear.

F. Block Filler: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores completely filled flush, free of pinholes. Provide multiple coats if required.

G. Prime Coats: Before applying finish coats, apply a prime coat. Re-coat primed and sealed surfaces where there is evidence of suction spots or unsealed areas to assure a finish coat with no burn-through or other defects.

H. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness and other surface imperfections will not be acceptable.

I. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections.

J. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.06 CLEANING

A. Clean-Up: During progress of work, remove discarded paint materials, rubbish, cans and rags at end of each work day.

B. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by washing and scraping; do not scratch or damage finished surfaces.

3.07 INTERIOR PAINT SCHEDULE

A. Specified products are those of Benjamin Moore.

B. Wood, 100% Acrylic Low Odor/Zero VOC Semigloss:
   1. First Coat: Eco Spec Latex Primer Sealer #231.

C. Wood, Clear Satin Urethane Finish:
   1. First Coat: Benwood Quick Dry Sanding Sealer #413.
D. Wood, Stain and Satin Urethane Finish:
   1. First Coat: Benwood Penetrating Stain #234.
   2. Second Coat: Benwood Quick Dry Sanding Sealer #413.

E. Gypsum Board, Acrylic Low Odor/Zero VOC Flat:
   1. First Coat: Eco Spec Latex Primer Sealer #231.

F. Gypsum Board, 100% Acrylic Low Odor/Zero VOC Low Sheen/Eggshell:
   1. First Coat: Eco Spec Latex Primer Sealer #231.
   2. Second and Third Coats: Eco Spec Latex Eggshell Finish #223.

G. Gypsum Board, 100% Acrylic Low Odor/Zero VOC Semigloss:
   1. First Coat: Eco Spec Latex Primer Sealer #231.

H. Ferrous Metal, 100% Acrylic Low Odor/Zero VOC Semigloss:
   1. First Coat: Super Spec Metal Primer M04.

I. Non-Ferrous Metal, 100% Acrylic Low Odor/Zero VOC Semigloss:
   1. Pretreatment: Etch.
   2. First Coat: Super Spec Metal Primer M04.

3.08 WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

B. Set aside extra paint for future color matches, or reuse by Owner. Habitat for Humanity, etc. Where paint recycling is available, collect all waste paint by type and provide for delivery to recycling or collection facility.

C. Close and seal tightly all partly used paint and finish containers and store protected in well-ventilated fire-safe area at moderate temperatures.

D. Place empty containers of solvent based paints in areas designated for hazardous materials.

E. Do not dispose of paints or solvents by pouring on the ground. Place in designated containers for proper disposal.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section describes the requirements for furnishing and installing access flooring system.

B. Related Sections:

1. Construction waste management is specified in Section 01505.
2. Joint sealants are specified in Section 07920.
3. Carpet tile is specified in Section 09684.
4. Diffusers are specified in Division 15.
5. Electrical and data boxes and grounding requirements are specified in Division 16.

1.02 SYSTEM PERFORMANCE

A. Structural Performance:

1. Floor Panels: Capable of supporting the following loads:
   a. Concentrated load of 1,500-lbs. applied to one square inch located anywhere on the panel, with a deflection and permanent set not to exceed .010-inch.
   b. Rolling loads of 1,000-lbs. applied to panels through a 6-inch diameter, 1-1/2-inch wide hard neoprene wheel with a surface deformation and permanent set not to exceed 0.020-inch after 10,000 passes of specified rolling load.
   c. Uniform load of 300-lbs. placed on a 1-square foot area at any location on the panel with a maximum top surface deflection of 0.060-inches. Panel shall not exceed a permanent set of 0.010-inches after the load is removed.

2. Pedestals: Capable of withstanding a bending moment of 1,000-inch-pounds and an axial load of 7,000-pounds.

B. Seismic Force Resistance:

1. Design Criteria: 2010 California Building Code, Chapter 16, Formula 32-2 with Ca = 0.40, Ip = 1.0, ap = 1.0, and Rp = 3.0. Wp shall include 90-psf for fixed contents (to account for bookshelf loading) plus the weight of the access floor.

2. Seismic Resisting System: Lateral seismic forces shall be resisted by cantilever action of each individual pedestal; bracing will not be permitted.

3. Panel-to-Pedestal Connection: Panels shall be positively connected to pedestals with mechanical fasteners to transfer seismic forces; stringers will not be required except where floor finish requirements do not permit use of bolted down panels. The connection at each panel corner shall be capable of withstanding 600-pounds of shear force between the panel and pedestal with a safety factor of 3.0 against failure.

4. Pedestal-to-Floor Connection: Connections between pedestals and floor shall use expansion anchors or epoxy anchors that are ICBO approved for seismic resistance. Adhesive anchorage of baseplate to floor will not be acceptable for seismic force resistance. Anchorage with powder-actuated fasteners (shot pins) will not be acceptable.

1.03 DESIGN REQUIREMENTS
A. Access floor system shall consist of modular and removable cementitious filled welded steel panels fastened onto and supported by adjustable height pedestal assemblies. Pedestal head and panel corner design shall provide a positive location and lateral engagement of the panel to the understructure support system without the use of fasteners.

1.04 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer’s technical data and installation instructions for each type of access flooring required; include manufacturer’s maintenance instructions.
C. Shop Drawings: Show complete layout of access flooring based on field-verified dimensions; include dimensional relationships to adjoining work. Include full size details; indicate materials, finishes, fasteners, edge conditions, accessories, understructure and other pertinent data. Include full size sheets at minimum 1/8” = 1’-0” scale and AutoCAD files.
D. Samples of each exposed metal finish and each type of floor covering and accessory.
E. Certification and Test Data: Manufacturer’s certification that access flooring complies with specified performance requirements.
F. Seismic Calculations: Calculations prepared by a Civil Engineer presently licensed in the State of California, verifying access floor system conforms with seismic design requirements.
G. Furnish ICBO approval documentation for access flooring.

1.05 QUALITY ASSURANCE
A. Installer’s Qualifications: Approved by access flooring manufacturer with documented successful installation experience of a similar scope.
B. Perform in-place test of installed pedestal to confirm compliance with specified overturning moment. Testing methods and procedures shall be as recommended by access flooring manufacturer and as approved by the University’s Authorized Representative.

1.06 DELIVERY, STORAGE, AND HANDLING
A. General: Comply with the requirements specified in Division 1.
B. Deliver access flooring components in original, unopened packages, clearly labeled with manufacturer’s name and item description.
C. Handle and store packages containing access flooring in a manner which avoids overloading building structure.

1.07 PROJECT CONDITIONS
A. Environmental Conditions: Do not proceed with installation of access flooring until installation area is enclosed and has an ambient temperature of between 40-deg. F. and 90-deg. F. and a relative humidity of not more than 70-percent.
B. Field Measurements: Check actual locations of walls and other construction to which access flooring must fit, by accurate field measurements before preparation of shop drawings; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

1.08 SEQUENCING AND SCHEDULING
A. Mark pedestal locations by use of 10-foot x 10-foot grid on concrete subfloor so that mechanical and electrical work can take place without interfering with pedestals.

1.09 EXTRA MATERIALS
A. Deliver extra materials to Owner. Furnish extra materials matching products installed, packaged with protective covering for storage and identified with labels clearly describing contents.

1. Furnish quantity of standard field panels and understructure components to support them equal to 20-panels with no cut-outs, 20-panels with diffuser cut-outs, and 20-panels with electrical and data box cut-outs.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Haworth TecCrete or approved equal.

2.02 FLOOR PANELS

A. Standard Field Panels: Modular panels, interchangeable, free of exposed metal edges in installed position with floor covering in place.

1. Nominal Size: 24-inch x 24-inch.

2. Size and Squareness Tolerance: Fabricate to plus or minus 0.015-inch with a squareness tolerance of plus or minus 0.015-inch.

3. Flatness: Fabricate to plus or minus 0.020-inch measured diagonally on top of panel.

4. Lightweight-Concrete-Filled Formed-Steel Panels: Lightweight-concrete-filled panels fabricated with flat top sheet and formed bottom pan formed from electrolytic-zinc-coated cold-rolled steel sheet and joined together permanently and structurally by hemming and joined to concrete core by adhesive to form an enclosed assembly.

5. Provide flat-bottomed panels at plenum dividers and air highway divider locations by using a steel plate welded to bottom of contoured panels if contoured panels are used.

2.03 FLOOR PANEL COVERING

A. As scheduled. Where high-pressure plastic laminate is scheduled, factory-laminate to panel by panel manufacturer.

2.04 UNDERSTRUCTURE

A. Pedestals: All-steel assembly including base, column with provisions for height adjustment, and head.

1. Pedestals: Size as required for lateral force resistance and finished floor height indicated. Pedestals shall be of structural quality steel conforming to ASTM specifications that specify minimum mechanical properties. Electrical tubing shall not be used. Connections transmitting seismic forces shall be by mechanical fasteners, welding or bearing.

2. Provide vibration-proof mechanism for making and holding fine adjustments in height over a range of not less than 2-inches. Include means of locking leveling mechanism at selected height.

3. Head: As required for direct bolting panels to pedestals.

2.05 ACCESSORIES

A. Colors and Finishes: As selected by the Architect from manufacturer's standards.
B. Cutouts: Fabricate panel cutouts to accommodate cable penetrations, air diffusers, and service outlets. Provide reinforcement or additional support if required. Fit cutouts with manufacturer's standard grommets or trim edge of cutouts with manufacturer's standard plastic molding. Install 16-gauge sheet metal cover plates with removable adhesive over all panel cutouts prior to panel installation. See Mechanical, Electrical, Tel/Data, Security, AV documents for additional information on required cutouts.

1. Make small device cutouts for swirl diffusers, electrical boxes, etc. in one quadrant of panel for field panels (not for edge panels) to allow for adjustment of floor tiles in the future.

C. Service Outlets: Manufacturer's standard assemblies for recessed mounting flush with top of floor panels, for power, communication and signal cables. Locate outlets in center of panels. Equip each service outlet with power receptacles.

D. Panel Lifting Device: Manufacturer's standard portable lifting device of type required.

E. Provide manufacturer's standard ramps, steps, fascias and grommets as indicated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Pre-Installation Adhesive Subfloor Field Test: Prior to proceeding with installation of pedestals, field test their adhesion to subfloor surfaces.

1. In areas representative of each subfloor surface condition, set typical pedestal assemblies in same adhesive and methods required for completed work.

2. Allow test installation to cure for 14-days, with pressure of 25-lbf applied vertically to pedestals during this period.

3. After curing, apply lateral loads against a straight steel extension bar inserted 2-inches into pedestal stems. Measure with spring scale the force needed to cause adhesive failure between pedestal base and subfloor.

4. Do not proceed with installation until pedestals resist overturning bending moment.

B. Locate each pedestal and complete any necessary subfloor preparation, and vacuum clean the subfloor of dust, dirt, and construction debris before starting installation.

C. Obtain Architect's approval of location of service outlets, diffusers, and other penetrations prior to commencing installation.

3.02 INSTALLATION

A. Install access floor system and accessories under supervision of the manufacturer's authorized representative to ensure rigid, firm installation free of vibration, rocking, rattles, squeaks, and other unacceptable performance.

B. Pedestal-to-Floor Connection: Connections between pedestals and floor shall use expansion anchors or epoxy anchors. Adhesive anchorage of baseplate will not be acceptable. Anchorage with powder-actuated fasteners (shot pins) will not be acceptable.

C. Layout floor panel installation to keep the number of cut panels at the floor perimeter to a minimum. Scribe panels at perimeter to provide a close fit with no voids greater than 1/8-inch where panels abut vertical surfaces.

D. Secure access panels to pedestal heads with captive fasteners.

E. Clean dust, dirt, and construction debris caused by floor installation, including vacuuming and damp mopping the subfloor area, and hand wiping other underfloor surfaces as installation of floor panels proceeds. Extend cleaning under installed panels as far as possible.
F. Perform cutting and trimming or other dirt-or-debris-producing operations as remotely as possible from installation area and in a manner to prevent contamination of subfloor surfaces under sections of access floor which already have been installed.

G. Level installed access floor to within 0.10-inch of true level over the entire area and within 0.0625-inch in any 10-foot distance.

H. Seal all joints between access floor and columns or walls and all penetrations. Coordinate with the work of Section 07920.

3.03 CLEANING, PROTECTION AND FINAL ADJUSTMENTS

A. After completion of installation, vacuum clean the entire floor system using HEPA-filter vacuums, damp mop and cover with continuous sheets of reinforced paper or plastic. Maintain and repair damages to protective covering until directed by Architect.

B. Replace access floor panels that are chipped, broken, stained, scratched, or otherwise damaged, or do not conform to specified requirements.

3.04 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

END OF SECTION
SECTION 10400
SIGNAGE

PART 1 - GENERAL
1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing the following types of signs:
   1. Room identification signs.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Manufacturer's construction details relative to materials, dimensions of individual components, profiles, and finishes for each type of sign required.
C. Shop Drawings: Furnish shop drawings for fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components. Show anchors, grounds, reinforcement, accessories, layout, and installation details.
   1. Furnish message list for each sign required.
   2. For signs supported by or anchored to permanent construction, furnish setting drawings, templates, and directions for installation of anchor bolts and other anchors.
D. Samples: Furnish samples of each exposed material, including letters and other graphics, showing finish, color, and qualities of fabrication and design.

1.03 QUALITY ASSURANCE
A. Comply with California Building Code (CBC) Section 1117B.5.

1.04 ENVIRONMENTAL QUALITY ASSURANCE
A. Adhesives, sealants, and sealant primers shall not exceed the VOC limits established in South Coast Air Quality Management District Rule 1168, effective date of July 1, 2005 and rule amendment date of January 7, 2007.

PART 2 - PRODUCTS
2.01 MATERIALS AND FABRICATION
A. Acrylic Sheet: Transparent, clear, semi-matte or non-glare, thickness specified.
B. Fasteners: Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface. Where exposed fasteners are required, provide tamper-resistant type fasteners.
C. Colored Coatings for Acrylic Plastic Sheet: Use colored coatings, including inks and paints for copy and background colors that are recommended by acrylic manufacturer for optimum adherence to acrylic surface and are non-fading for the application intended.
D. Interior Signage:
   1. Signs shall be sign manufacturer's standard one piece photopolymer sign face with tactile Braille and letters or acrylic sign face with applied tactile lettering and Braille, at manufacturer's option, and shall be interior rated.
2. Sign materials and fabrication shall comply with applicable CBC and ADA signage requirements.

3. Sign Finish: Eggshell, matte, or non-glare as selected by the Owner's Representative.

4. Copy: 5/8-inch minimum, 2-inch maximum as recommended by sign manufacturer for required copy, raised minimum 1/32-inch.

5. Letters: San Serif, style as indicated or as selected by the Architect.

6. Braille: Contracted Grade 2 Braille complying with CBC Section 1117B.5.6.

7. Mounting: Vinyl foam tape unless mechanical fasteners are indicated.

2.02 SIGN SUMMARY

A. Room Identification Signs:

1. Provide one sign adjacent to latch side of doors or on the nearest adjacent wall where indicated. Signs shall identify room name as directed by the Architect.

2. Provide signs with raised upper case letters with Grade 2 Braille. Comply with ADA Article 4.30.

3. Mount signs 60-inches above finish floor to centerline of sign.

4. Comply with CBC Section 1117B.5.1.1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate where indicated and as required by applicable codes and secure with specified fasteners.

B. Install level, plumb and at height indicated or required, with surfaces free from distortion or other appearance defects.

C. Where signs are adhesively applied, adhesive shall be spread over full contact area.

3.02 CLEANING AND PROTECTION

A. At completion of installation, clean soiled surfaces in accordance with manufacturer’s instructions. Protect units from damage until final acceptance.

3.03 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

END OF SECTION
SECTION 10520
FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION
A. This Section describes the requirements for furnishing and installing the following:
   1. Fire extinguishers.
   2. Fire extinguisher cabinets.
B. Related Sections:
   1. Construction waste management is specified in Section 01505.

1.02 SUBMITTALS
A. General: Comply with the requirements specified in Division 1.
B. Product Data: Furnish for each type of product specified. For fire extinguisher cabinets, include rough-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type and materials, trim style, door construction, panel style, and materials.
C. Samples: Furnish samples of each type of metal finish required, prepared on metal of same thickness and allow to be used in the final work. Where finishes involve normal color and texture variation, include sample sets showing full range of variations expected.

1.03 QUALITY ASSURANCE
A. Obtain fire extinguishers and cabinets from one source from a single manufacturer.
B. UL-Listed Products: Provide fire extinguishers which are UL-listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher specified.

PART 2 - PRODUCTS

2.01 FIRE EXTINGUISHERS
A. General: Provide fire extinguishers for each extinguisher cabinet. Comply with requirements of governing authorities. Fire extinguishers shall be full charged and tagged in accordance with requirements of the authority having jurisdiction.
B. Multi-Purpose Dry Chemical Type: Potter-Roemer “3010” or approved equal UL-rated 4A:60BC, 10-lb. nominal capacity, in enameled steel container.

2.02 FIRE EXTINGUISHER CABINETS
A. Approved Manufacturers: Potter-Roemer, Inc. “7060” or approved equal.
B. Tub: Heavy-gauge, white baked enamel. Where fire extinguisher cabinets are installed in fire-rated partitions, provide manufacturer's UL or Warnock Hersey listed liner for 1- or 2-hour wall systems in compliance with UBC Standard 43-6.

C. Cabinet Type: Recessed.

D. Trim Style: Manufacturer's standard.

E. Door Material: Stainless steel with No. 4 finish.

F. Door Glazing: Clear tempered float glass.

G. Door Style: Duo vertical panel with lock and Break Rite handle.

H. Door Hardware: Manufacturer's standard door operating hardware for cabinet type, trim style, and door material and style specified. Provide door pull, exposed or concealed, and friction latch. Provide concealed or continuous type hinge permitting door to open 180-deg.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install items in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.

B. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim in compliance with manufacturer's instructions.

C. Securely fasten fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer's instructions.

3.02 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

END OF SECTION
SECTION 10676

METAL LIBRARY SHELVING

PART 1 – GENERAL

1.01 DESCRIPTION

A. This specification covers installation of Owner-furnished metal library shelving.

B. Related Sections:
   1. Construction waste management is specified in Section 01505.
   2. Access Flooring is specified in Section 10270.

1.02 SYSTEM DESCRIPTION

A. Completed installation shall present a neat and finished appearance and shall be free of exposed sharp edges and projections.

1.03 QUALITY ASSURANCE

A. Installer: Firm acceptable to manufacturer and with minimum five year’s successful experience in installation of shelving systems comparable to those required.

B. Seismic Requirements: Anchor shelving for forces equivalent to requirements of California Building Code for Seismic Zone 4 and I-1.0.
   1. Design system, including columns, bases, connections, anchorage to access flooring and subsequent bracing required beneath access flooring, capable of resisting lateral seismic force of \( FP = 0.30 \; W_p \) in any direction, acting simultaneously with vertical seismic force equal to one third of horizontal force \( F_p \).
      a. Allowable stresses and other design criteria shall be as permitted by referenced code.
      b. \( W_p \) is defined as the total weight of the shelving system plus 50 psf of shelving to account for book storage.
      c. Stresses and deflections shall be investigated for shelves fully loaded in combination with seismic forces, and loaded one side on combination with seismic forces.
      d. Shelving shall be anchored to structure, regardless of height.
   2. Anchors to structure shall be with specified drilled-in anchors at ICBO approved allowable capacities without the one third increase in allowable stress permitted in CBC.
   3. Overhead bracing and bracing between stacks shall not be permitted.

1.04 SUBMITTALS

A. General: Comply with the requirements specified in Division 1.

B. Shop Drawings: Submit shop drawings for each type of library bookstack range equipment, showing details, dimensions, detailed layout of underfloor anchorage system, and layout of installation.
C. Seismic Certification: Submit detailed certification by Structural Engineer licensed in California indicating system complies with applicable codes and Contract Documents for seismic design.

1. Submit calculations of seismic forces for fully loaded bookstacks, clearly indicating compliance with seismic design requirements.

1.05 DELIVERY, STORAGE AND HANDLING

A. General: Comply with the requirements specified in Division 1.

B. The Owner will deliver metal library shelving to the Project site.

C. Unload materials carefully and store on clean, dry surface or raised platform in safe area protected from weather.

1.06 SCHEDULING

A. Sequencing: Coordinate shelving installation with requirements of related work.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Metal library shelving will be furnished by the Owner.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine areas to receive shelving and verify setting conditions and dimensions are correct.

B. Verify related work has been properly installed.

C. Beginning of installation signifies acceptance of conditions and related work.

3.02 INSTALLATION

A. Prior to completion of access flooring installation and installation of underfloor utilities clearly mark all required anchor points on structural slab for coordination with other trades.

B. Prior to installation of floor finishes and after completion of the installation of underfloor utilities install required underfloor structural anchors and bracing. Bridge and span conflicting utilities as required.

C. After installation of flooring is complete, install units at locations shown, in continuous ranges made up of number of units shown, complying with manufacturer's instructions.

1. Provide spacer washers which protect finish at fasteners through finished surfaces.

2. Comply with Quality Assurance requirements for anchoring bookstacks to withstand seismic loads.

D. Set units plumb and level, using adjustable leveling devices.

E. Install shelves at spacing indicated, or if not indicated, at equal spacing in each unit.

F. Install accessory items in locations indicated.
3.03 ADJUST AND CLEAN

A. Verify moving parts are operating freely.

B. Clean exposed surfaces and touch-up marred finishes or replace components as necessary to eliminate damage and indications of deterioration.

3.04 PROTECTION

A. Protect library shelving system installation from damage during remainder of construction and until substantial completion.

B. Replace components damaged prior to substantial completion.

3.05 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with the requirements of Section 01505 Construction Waste Management for removal and disposal of construction debris and waste.

END OF SECTION
SECTION 11130
DISPLAY MOUNTS

PART 1 – GENERAL

1.01 Description
A. This section covers OFCI flat panel display mounts video monitors. The products in this section are specified for installation by the General Contractor because of the multiple trades involved, the coordination required between these trades, and the structural for verification.

B. Section Includes

1. Install owner furnished video monitor mounts with hardware and accessories, mounts are owner furnished contractor installed.
2. Provide coordination with electrical, structural, ceiling and on-site trades as required for complete installation.

C. Related Work

1. Section 05310 - Metal Decking.
2. Section 05120 - Structural Steel.
3. Section 09260 - Gypsum Board Systems.
4. Section 09255 - Lay-in Ceilings.
5. Section 11135 - Audiovisual Equipment.
6. Division 16 - Electrical.

1.02 Submittals

A. Submit in accordance with Section 01330, Submittal Procedures.

B. Submit Manufacturer’s Literature and Data: Installation Instructions, including wiring diagram for motor operated screens and materials description for each type of projection screen and mount.

C. Submit timing information. Provide a letter to the General Contractor indicating when the products will be provided to the project site and when they will be installed. The schedule in this letter should represent a coordinated schedule with other trades.

PART 2 – PRODUCTS

2.01 Flat Panel Video Monitor Mount Acceptable Manufacturers

A. Peerless - OFCI

2.02 Flat Panel Video Monitor Mount Materials

A. Video Monitor Mount shall attach with seismically rated anchors.
B. Video monitor shall accept video monitor from 14" to 33" wide and up to 120 pounds dead load.

C. Video monitor mount shall hold the flat panel against the wall with no tilt.

D. Mechanical parts and metal mounting brackets shall be rated factory hardware. Custom field mounting shall utilize rated hardware.

E. Mounts Acceptable material: Peerless
   1. For the 30" to 50" Flat Panels: SP850-UNLP-GS

PART 3 – EXECUTION

3.01 Wall Display General Installation:
   A. Wall mount in locations as shown in architectural drawings.
   B. Install mounts accurately, in alignment and where shown. Display mounts shall be level and set parallel to line and plane of surface as shown.
   C. Provide anchoring devices, blocking, or framed construction and fasteners as shown and as necessary for securing screens to building construction.

3.02 Flat Panel Monitor Mount Installation:
   A. Ceiling or wall mount in locations as shown in architectural drawings.
   B. Install mounts in architectural alignment and where shown. Mounts shall be level and set parallel to line and plane of surface as shown.
   C. Provide weight bearing anchoring devices, blocking, or framed construction and fasteners as shown and as necessary for securing mounts to building construction. Provide structural engineering to satisfy General Contractor for project site requirements.
   D. Provide seismic anchoring devices and fasteners as necessary for securing mounts to building construction.
   E. Coordinate or provide electrical power to video monitors.
   F. Coordinate or provide signal wireway to AV receptacle plates as specified.

3.03 Cleaning:
   A. After installation clean all surfaces and protect from damage until completion of the project. Viewing surfaces shall be cleaned only in accordance with the manufacturer’s instructions.

3.04 Adjusting
   A. Movable parts shall be cleaned and adjusted to operate-as designed without binding or deformation of any part. Motor controls shall be verified to insure operation as specified.

END OF SECTION
SECTION 11135

AUDIOVISUAL

PART 1 – GENERAL

1.01 Scope of Work:

A. Work of this Section includes:

1. Furnish labor, materials, and supplies necessary to provide connections for a complete and operable Audio and Video Systems as described herein, and as shown on the "AV" series drawings.

2. The Audio Visual Contractor will be installing wiring and devices as designated in this specification and on the drawings. Device and installation warranty will be with the party who supplies or installs each system or subsystem.

3. Pay all fees and charges for inspections, permits, and other services required for the work of this Audio Video Contractor.

4. Attendance at construction meetings for trade and onsite coordination. Meetings are held in the construction trailer onsite and scheduled by the General Contractor.

5. Specialty Subcontractor: All video projector mounts are specified as Monger Mounts as requested by the University. The scope of this work is to coordinate with the specialty contractor for all video projector mounts, projector adaptor plates, structural attachments and seismic bracing. This installation is to be fully executed by Monger Mounts. The Audio Visual Contractor is to provide and install all signal connections including video and control.

6. SPECIAL CONDITIONS: Some devices specified in this document are provided and installed by the Audio Visual Contractor. Note that some devices will be purchased by State University contract. These devices are labeled OFE as Owner Furnished Equipment on the drawings and also designated in the specification. These devices will be provided to the jobsite by the University representative for installation by the Audiovisual Contractor. While the University will accept responsibility of all devices provided by them as being fully functional, the Audio Visual Contractor accepts responsibility for the integrity of all wiring connecting these devices.

7. There are four levels of University and Contractor acquisition and installation. These scopes of work are defined in the following way:

a. OFOI: Owner Furnished and Owner Installed: The Owner purchases the devices and installs these devices.

b. OFCI: Owner Furnished and Contractor Installed: The Owner purchases the devices and hands them over to the installation contractor. These devices are not warranted by the installation contractor, but they are installed and programmed by the installation contractor.

c. CFOI: Contractor Furnished and Owner Installed: The Installation contractor purchases these devices for installation by the Owners representatives. This category has no entries.

d. CFCl: Contractor Furnished and Contractor Installed: The Contractor purchases and installs these devices. These devices and their operation is fully warranted by the installation Contractor.

B. Related Work Specified Elsewhere:
1. Division 16 - Electrical - Work of this section includes all conduit for the audio, video and control signals. Note that locations for power and network as shown on the AV drawings, but are part of the Electrical scope of work. Coordination with this section is required. Refer to EA Drawings.

2. Division 11 - Projection Screens and Mounts - Work of this section includes all projection screens, structural attachments and coordination with power where required. This work must be coordinated with the video projector mount subcontractor for position and alignment and with the General Contractor for structural attachment. The Audiovisual Contractor will connect control for all motorized screens. Refer to AV and architectural drawings.

1.02 Overall System Requirements:

A. Provide and install fully functional audio, video and control systems which perform the functions described and operate without excessive noise or distortion. Installed system shall operate reliably and as designed.

B. Provide Audio Visual systems which have:

1. Permanently installed components with proper alignment, sufficient ventilation and cooling, and adequate access for maintenance.

2. Wiring and cabling which is properly supported, protected, labeled, and dressed. Include spare conductors as appropriate, and pull-cords in empty conduits. Where conduits are less than 40% filled by this work, provide empty inner duct to provide pathway for future fill.

3. Equipment which is fully adjusted, optimally aligned, functionally tested, and performance tested from end-to-end under all programmed conditions.

4. Documentation which is fully communicative, and thoroughly describes the system design, installation, interconnection, operation, maintenance, and service trade contract.

1.03 Audiovisual System Description: Audiovisual systems in the building are divided by type. Some systems are installed by the Owner and some are installed by the Audio Visual Contractor. Refer to room descriptions.

A. Each group study room of four persons or more has provisions for a wall mounted flat panel for video display. All group study rooms are OFCI (Owner Furnished and Contractor Installed) using conduits installed by the base building contract. Conduit is installed for laptop VGA, HDMI and Audio inputs through one floor pocket mounted in the center of the room under a conference table. Either computer or video inputs can connect to the flat panel display on the opposite wall. All devices are hand operated, no remote control system is installed.

B. Backbone System Description: Signal Backbone systems provide the following for the entire building:

1. A master antenna coax will be installed to collect and distribute broadcast television to selected locations with the building. Distribution will include the Lecture Halls, classrooms, conference rooms, and lobby.

2. A building wide page system is provided with background music capability. The page system is divided into zones. The zones primarily include a public zone and a staff zone. Pages can be delivered using telephone page ports (special numbers on any interior telephone), or, for higher fidelity, a page microphone can be used at the circulation desk. A 365 day clock will deliver timed announcement to the library zones selected. The timed announcements are expected to be closing time warnings and building closed announcements for both weekdays and week-ends.

1.04 Combined Prescriptive and Performance Requirements:

A. The Audio Video Contractor is advised that this section of Division 11 includes a combination of prescriptive and performance specifications. Compliance with the performance specifications, and coordination and integration of the performance and prescription requirements, will require substantial design detailing on the part of the Audio Video Contractor.
B. Where stated, the prescriptive requirements establish the minimum quality, characteristics, and types of components, equipment, and materials to be used to achieve the stated system performance requirements. The Audio Video Contractor is advised, however, that prescriptive specifications have not been provided to satisfy all of the specified performance requirements.

C. The Audio Video Contractor shall carefully consider all of the requirements for each of the Division 11 subsystems. Any questions regarding the intent of these requirements, the scope of the systems, or their coordination requirements must be submitted in writing to the Owner.

1.05 Intent and Interpretations:

A. The word “provide”, where used in these specifications, can mean to acquire, pay shipping and tax and deliver to the project site these listed devices. There devices will appear on the submittal drawings and the project equipment list. Detailed design provision, integration, installation, testing, and adjusting may not be part of the contract requirement.

B. The phrase “provide and install”, where used in these specifications, shall mean to acquire product, perform detailed coordination (where necessary), integrate, install, test adjust, and document.

C. The word “install”, where used in these specifications, shall mean to perform detailed coordination (where necessary) for devices. These devices may be provided by others (typically the Owner). Install means to integrate, mechanically connect, electrically connect, test, adjust and document.

1.06 Special Requirements:

A. Because Audio Video devices have short model number life expectancies, model and even features of devices will change during the construction and acquisition period of this project. The audiovisual contractor is expected to update the model numbers as appropriate and submit these adjusted model numbers with the submittal package.

B. The Audio Video Contractor is advised that any products they supply for this project re to be products for which they hold active dealerships. Any and all warranty responsibilities are the installation contractor's responsibility for those products they supply.

C. All devices are new "A" stock, not used and have never been connected to another system. All products are current models of the specified device.

D. By accepting the project, the Audio Video Contractor represents and warrants as follows:

1. That it has thoroughly reviewed the specifications and related drawings noted the interrelationships between the systems and identified the interfaces with the work of other Sections and Divisions.

2. That it has reviewed the device plans, the control panel drawings, the functional descriptions, and the device schedules attendant to the various Systems. The Audio Video Contractor acknowledges that these items are complementary, and any requirement shown for one is the same as if it were shown for all. The Audio Video Contractor further warrants that it has reconciled these items with one another to determine the hardware and software requirements.

3. That it has reviewed the wiring requirements shown in the drawings and in the specifications. The Audio Video Contractor acknowledges that the wiring identified in the drawings and specifications is intended to establish a minimum performance requirement.

4. The Audio Video Contractor acknowledges that the size and amount of conduit has been shown explicitly. Explicitly stated sizes and quantities are intended to indicate minimum acceptable sizes and quantities. The Audio Video Contractor warrants that it has reviewed the drawings carefully and ascertain the proper size and quantity of conduit and appurtenances, and that it understands that the conduit routing is the Audio Video Contractor's responsibility.
5. That it has reviewed the various diagrams for each specified system, the system descriptions, product specifications, functional requirements, and has selected products and interconnecting wiring that will provide systems meeting all of the requirements.

6. That it has considered the amount of coordination, engineering, testing, quality control, safety program and project management time required to meet the overall project requirements, as well as the cost of other labor needed to meet the requirements for the specified systems.

7. That it has considered the time and materials necessary to complete all product data submittals, shop drawings, record drawings, operations manuals, maintenance manuals, training manuals, training classes and software documentation.

1.07 Base Bid Systems and Subsystems:

A. Price quote documentation: Submit dollar amounts and equipment list documentation for the entire system including all subsystems. Note that this project may undergo post-bid negotiation. Unit pricing is required as a basis for this negotiation. Unit pricing for the Owner supplied devices is for installation of audio, video and control connections as noted on the drawings.

B. Provide an ADD and DELETE factor for changes to the system. This factor should be based upon current list price for the device or material added to the project or deleted from the project.

1. ADD Factor: A multiplier for each device added to the project. This multiplier includes cost of the product, shipping, tax, engineering and installation. If the device being added is labor intensive, identify any other factor which may apply.

2. DELETE Factor: A multiplier for each device deleted from the project. This multiplier includes cost of the product, shipping, taxes paid, restocking charge, engineering (documented as performed) and any installation (documented as performed).

3. INSTALLATION Factor: A multiplier for each device added or deleted from the project. This multiplier includes only the labor to install a product or device but does not include the cost of the device. This installation quote should include engineering (documented as performed) and shop or field installation and can be adjusted for labor intensive installation devices.

C. Provide Base Bid quote for all work shown in the installation drawings: Wiring and installed systems for all rooms. Wiring to include video, audio and control wire and termination at wall and floor plates, wire to the connecting location, termination at device or patch points within the equipment racks. Include receptacle plates, patch panels, and interconnecting Wiring. Include audio and video equipment listed in this specification and shown on the project drawings. Note that some devices including video projectors and flat panel displays are Owner Furnished and will be purchased by the University and installed by the Audio Visual Contractor to connections installed by this scope of work.

1.08 Quality Assurance:

A. All materials must be newly manufactured current production models and Conform to all applicable codes and the relevant standards listed below:
   - American National Standards Institute (ANSI)
   - Electronic Industries Association (EIA)
   - Institute of Electrical and Electronic Engineers (IEEE)

B. Experience: The provider shall specialize in the installation of Audio Visual systems. have a minimum of five years of documented experience in the field of Audio Visual system installation, and be an approved vendor for components installed.

C. Supervision: Designate a single supervisor to oversee the installation work for the duration of the work to ensure that the system is installed in accordance with the specification and drawings.
1. The supervisor shall maintain adequate staff and be responsible for installing and testing the system on schedule.

2. The supervisor shall have at least five years of documented, recent, and similar project experience.

D. The Owner reserves the right to make use of the system prior to the completion of the punch list. Temporary use of the equipment shall not constitute an acceptance of the system or any part. The Owner shall not pay additional cost to the Audio Video Contractor and the commencement of the warranty period shall not begin for the system or any device prior to the completion of the punch list and final acceptance of the system by the Owner.

E. Codes: Comply with all applicable laws, regulations and codes.

F. Should the Audio Video Contractor at any time discover a discrepancy between these Sections and the project documents, with respect to significant variance between location, violation of code requirements, or any other discrepancies, the Audio Video Contractor shall notify the Construction Manager for clarification and shall not proceed with the work affected until this clarification has been made.

G. The Audio Video Contractor shall promptly notify the Construction Manager in writing of any difficulties that may prevent proper coordination or time of completion of this work. Failure to do so shall con statute acceptance of construction site and indicate that the site is suitable in all ways for this work, except for defects that may develop in work of others after commencement of system installation.

H. Audio Video Contractor Special Conditions:

1. The Audio Video Contractor shall be licensed as required by local regulations. Each Sub Contractor to the Audio Video Contractor shall have held a valid and applicable State Contractor’s license valid for at least 5 years. Having held a general business or retailer’s license shall not be construed as meeting this requirement.

2. The Audio Video Contractor shall, if not union, must reach signed agreement with the project site General Contractor and the Owner regarding union status of the onsite workers and products brought to the project site.

1.09 Submittals:

A. Submit a project schedule for the entire project within one month of award of contract. This general calendar is to be maintained with the General Contractor on a weekly basis. All work of this subcontract will be fully coordinated with the project as a whole.

B. Product Data Submittals: Equipment List and Product Data Sheets: Equipment specification sheets are necessary for the equipment which is contractor supplied. The Owner is responsible for providing cut sheets for all equipment they are supplying to the project. Owner Furnished cut sheets are to be provided to the contractor on a timely basis because the installer will have to provide specific terminations and connections.

1. Following Manufacturers List approval, submit complete equipment list.

2. List each and every specified item, and all proposed material and equipment to be furnished. For each item, list the manufacturer’s name, model or catalog number, the quantity, and special conditions or exceptions (if any).

3. Include a copy of the manufacturer’s catalog or specification sheet for each item. Mark each sheet with same item reference number(s) used on the equipment list. This number should correspond to the specification. If more than one item or version is shown on a sheet, clearly mark the sheet to indicate which item(s) or version(s) are being submitted.

C. Technical Submittals:
1. Submit shop drawings for approval prior to fabrication (no "typical" diagram will be considered).

2. Shop drawings shall be submitted for review and approval prior to fabrication and installation.
   Submit shop drawings for:
   a. Plan drawing showing location of all installed devices, including rack location, faceplate locations, junction/pull boxes, etc. Enlarged floor plans (classrooms, equipment rooms, etc.) with both floor plans and reflected ceiling plans. Show all devices.
   b. Loudspeaker locations, orientation and mounting.
   c. Show exact sizes, types, and locations (including mounting heights) for each hardware item to be installed. Hardware includes items installed by the Electrical Contractor for the AudioVisual Contractor. Hardware includes each back box, pull box, junction box, cabinet, conduit, sleeve, gutter, etc.
   d. For each run of conduit or raceway; show the proposed types and quantities of wires and cables to be installed (Run Sheet). Show exact fills for each run.

3. Submit samples of engraved labels, cable marking system, and face plate etching.

4. Coordination Schematics:
   a. Following approval of the coordination single-line diagram, prepare a point-to-point wiring diagram of each interconnection between systems.
   b. Cross-reference each diagram to the Interface points shown on the coordination single-line diagram, using the same designations.
   c. Wiring diagrams showing point-to-point connections between components, including terminal numbers, color and number coding of each conductor, and connection technique to be used. Give special attention to, and show complete details of the shields and ground conductors.

5. Fabrication Shop Drawings:
   a. Scaled and dimensioned drawings of all custom assemblies and fabricated items. Develop drawings so they are suitable for fabrication of the items, including mechanical and electrical work.
   b. Include details of all components, materials, finishes, and colors, sufficient to reveal the item's appearance and its compliance with the Contract Documents.
   c. Fabrication shop drawings shall include, but not be limited to:
      (1) Custom control panels.
      (2) Rack panel layouts (for each equipment cabinet)
      (3) Custom speaker enclosures and mounts
      (4) Details for mounting in custom casework

6. Preliminary Colors and Finishes:
   a. For each item or type of material which is available in more than one color, finish, or style, submit available colors, finishes, and styles for selection by the Architect/Owner. Submit written descriptions, photographs, color charts, swatches, samples, etc., as needed to enable consideration of all the manufacturers' standard colors, finishes, and
styles. Where appropriate, include are commendation for each choice.

b. Submitted colors, finishes, and styles shall include, but not be limited to those for the following: (1) Equipment rack and cabinets, (2) Wall plates and device covers, (3) Control panels, (4) Switch Caps, (5) Loudspeaker grilles.

1.10 Ownership:

A. The installation contractor is to provide all hardware and software the project. The software shall include the remote control program software and all custom software files and GUI written for the system operation. The installation contractor is to retain a copy of this software. If the Owner has overwritten or rendered the system inoperable during the warranty period because of software changes, the installation contractor will not be bound by the warranty.

PART 2 – PRODUCTS

2.01 General

A. Components are to operate on a 110 to 120 volt, 60 Hz electrical supply. All devices shall be rack-mountable in a standard EIA 19-inch rack unless otherwise noted.

B. The components listed in this section are the basics of the audiovisual design. Requirements listed are minimum standards for each component. All of the properties of the components/systems should be considered listed in full.

2.02 Electronic Audio Equipment:

2.03 Video Display Equipment:

A. 32" Flat Panel Color Monitor: (OFCI) 32 inch (measured diagonally) wall-mountable video monitor with 16:9 and 4:3 aspect ratios for conference rooms and the larger group study rooms.

1. Acceptable material: OFECI Model as determined by Owner: Benchmark: NEC V321-2

2. Accessories Required: OFCI Model as determined by Owner. Benchmark: NEC·wall mount kit SP850-UNLP-GS

   a. 32" Flat Panel Color Monitor: (OFCI) 32 inch (measured diagonally) wall-mountable video monitor with 16:9 and 4:3 aspect ratios, WXGA (1366 x 768), TFT, with internal HD tuner for the smaller four occupant group study rooms.

   b. Contractor shall provide complete with all connection cables to AV video floor box, including VGA cabling, HDMI and Audio Cabling.

2.04 Electronic Video Equipment: None

2.05 BUILDING WIDE PAGE SYSTEM is existing, this section provides for a description of existing system for the AVC to connect new speakers to existing system: This system is provided and Installed by AVC

A. Acceptable material: QSC CX302V

B. Page Loudspeaker System: (CFCI) provide a 6-inch, ceiling-mounted loudspeaker systems for the public and staff page systems.

   1. Acceptable Materials: Atlas-Sound loudspeaker with 70 volt matching transformer. FAP42TC.

C. Public area Ceiling Mounted Loudspeaker System: (CFCI) Provide a recessed ceiling-mounted loudspeaker
system for surface mount in the public areas of the library. Loudspeaker shall have a 190 degree dispersion to the 6dB down point.

1. Acceptable Materials:
   a. Atlas-Sound loudspeaker with 70 volt matching transformer: VTF-77UCS.
   b. 4-11/16" enclosure and adaptor ring.

D. Public area Ceiling Mounted Loudspeaker System: (CFCI) Provide a 24-inch square poly planer, ceiling mounted loudspeaker system for wide dispersion in those areas of the library with special "finned" ceiling.

1. Acceptable Materials:
   a. Sound Advance loudspeaker with 70 volt matching transformer: CT73ST8.
   b. Sound Advance enclosure model PBB2.0.
   c. Custom: Four corner mounted chain hangers per loudspeaker

2.06 Cable: All cable installed in this project shall be rated for digital signals. All cable shall be Plenum grade as required. All cable is Contractor Furnished and Contractor Installed.

A. Loudspeaker Cable: Provide stranded conductor, jacketed, twisted-pair cable. Conductor jackets are to be color-coded to enable consistent phasing.
   1. For low impedance connections: 12AWG - Acceptable Product Belden 8477
   3. For classroom distributed loudspeaker systems: 16 AWG - Acceptable Product Belden 8471.

B. Suitable multi-pair cable may be submitted for use in lieu of single pair where applicable. Consistent wire gauge, impedance, jacket thickness, capacitance, and velocity is required.

C. Provide plenum rated cable for all audiovisual cable where required by code.

D. Portable cables: Provide cables 20' in length for interconnecting the power, video and microphone signals between portable audio and video devices and the installed system using the input plates.

2.07 Connectors: All connectors are Contractor Furnished and Contractor Installed.

2.08 Hardware:

A. Audiovisual System Face Plates: Provide metallic cover plates at all control, switching and jack locations. Black semi-gloss baked enamel engraved cover plates with white in-filled lettering for all black control room wall locations. If wall surface is white, provide white engraved cover plates with black in-filled lettering. Supply stainless steel cover plates in classroom wall locations having fabric covered wall treatment. Verify style and finish on-site with Architect/Owner.

B. Receptacle Panels: Room panels shall be modular and fit onto the backboxes negotiated with the Electrical Contractor.
   1. As required

C. Terminal Cabinets, Boxes and Conduit: All terminal cabinets and junction boxes housing audio cabling will be
2.09 Labeling:

A. Audio Visual System Face Plates: Silk-screened and coated lettering shall identify individual plate mounted receptacles. Connector identification shall denote function and unique input/output number. Center lettering vertically adjacent OVER appropriate connector. Connector mounting will allow sufficient finger clearance for connector insertion and removal without interference from adjacent connectors. Coordinate finish with Architect/Owner.

B. Electronic Device Face Plate Labels: Provide permanent labels as specified and shown on detail drawings. Rigid engraved plastic labels fastened with epoxy or Silicone Seal are acceptable. Provide contrasting infill paint. Provide black letters on white plate (white walls) and white letters on black plate (black walls). Dymo type labels are not acceptable.

1. Control room video monitor identification faceplates shall be large: Two-inch high with broad stroke lettering for reading in low light situations. Device labels shall be appropriate the device being identified.

C. Provide a neatly labeled floor plan with as-built locations of all audiovisual jacks. Locate floor plan under a clear Plexiglass cover on one control room wall adjacent to one equipment rack. Minimum size of chart: 8-1/2 inch x 11-inch.

PART 3 – EXECUTION

3.01 Audiovisual Summary Description:

A. Instruction and conference rooms are configured for use by the casual user. Floor pockets are installed for integrated signal connections with separate compartments and faceplates for power, telco and data and audiovisual. Wall mounted input plates provide connectors for audiovisual with adjacent connector plates for AC line power and network and voice telephone connection. All rooms are configured for use by the presenter who will typically be “used to” the room. These rooms intend to follow the campus standard. The flat-top podium, the desk teaching station or conference table will provide a laptop connections as well as composite inputs for portable audiovisual devices. Receptacle plates are mounted in each room as provision for connecting portable devices.

3.02 General:

A. The following is required for acceptance of the audiovisual system by the Owner:

1. Install complete and functioning audiovisual system specified.
2. Label equipment and cables as specified and corresponding to functional diagram.
3. Conduct adjustments and preliminary testing.
4. Report results of preliminary testing along with system documentation.
5. Participate in acceptance test and deliver final system and documentation.
6. Conduct any adjustments or re-testing required meeting the specifications.
7. Provide training to individuals designated by the Owner.

3.03 General Requirements:

A. All equipment except portable equipment shall be held firmly in place. This includes racks, conduits, cables,
amplifiers, and other television and electronic equipment. Fastenings and supports shall be adequate to support their own loads with a safety factor of at least three.

B. Include blank or vent face plates where equipment is not mounted.

C. Submit shop drawings for custom fabrications including custom panels, receptacle plates, patch panel layouts, and rack elevations to the Owner for review and approval. Make submittals at least seven (7) days prior to scheduled fabrication. Note on the submittal the dates of scheduled fabrication.

1. Do not commence work on any portion of the project requiring Owner's approval prior to obtaining such approval. Work commenced and installed prior to review and approval shall be accepted at the discretion. Installation does not imply acceptance nor review for acceptance.

D. Keep at the job site an up-to-date complete record set of prints and specification. Make daily corrections and show all changes from the original contract drawings. Final As-Built drawings will be required at the conclusion of the project.

E. Keep the job adequately staffed at all times. A qualified engineer approved by the Owner and employed by the Contractor shall exercise engineering supervision over the entire installation and shall inspect the installation at least daily. An inspection log shall be kept with the job site documentation. Unless through illness, loss of personnel, or other circumstances beyond the control of the Contractor intervene, keep the same individual in charge throughout the execution of the work.

F. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory results. Watch for conflicts with work for other contractors on the job. Execute, without claim for additional payment, moderate moves or changes as necessary or required by the Owner prior to installation commencement to accommodate minor design changes, rack-out layout changes, additional equipment, or to preserve symmetry and pleasing appearance.

G. The Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract. All clean up, restoration, and removal noted above will be by the Contractor and at no cost to the Owner. If the Contractor fails in its duties under this paragraph, the Owner may upon notice to the Contractor perform the necessary clean up and deduct the costs thereof from any amounts due or to become due to the Contractor. It shall be the Contractor's responsibility to remove trash from the areas it is working in and bring trash and debris to the dumpster. The Contractor will not use the General Contractor's dumpsters or trash disposal without prior approval of the General Contractor.

H. Site Conditions:

1. Provide secure storage onsite for tools and products not yet installed in the hardware.

2. Clean the work site and keep the area free of litter and trash. Dispose of all containers from the jobsite.

I. The Owner will retain final authority on control software or operational decisions. The Architect will retain final authority on architectural matters including finish, color, location, and style. Submittals such as receptacle plates must be approved by the Architect or finish, color and style. Submittals must therefore follow procedure and be timely allowing for sufficient evaluation and response time.

3.04 Equipment Installation:

A. Components and devices shall be mounted in racks using the specification drawings for guidance. Equipment racks shall be loaded in the following manner: AC Power panels shall be the bottom-most panel. Rack operating lights shall be the topmost panel. User controls shall be grouped at standing or seated eye level. Those devices requiring less adjustment or operator attention shall be mounted higher or lower in the rack.
1. Mount equipment in racks and consoles using Black Torx head machine screws with nylon washers in each mounting hole. For items not incorporating manufacturer's mounting attachments, furnish mounting methods: ears, trays, or shelves as required for mounting equipment. Support heavy and/or deep items at both front and rear rack rails, as necessary.

B. Audiovisual contractor shall test and verify all audio, video, copper and optical fiber. Test results shall be supplied with preliminary test results listed in this specification. If an electrical fault exists or if a break or loss occurs in the optical fiber installation, this fault shall be reported to the General Contractor for correction by the installing Electrical Contractor.

C. Conduit:

1. Each of the following cable groups shall be separated and shielded from one another entering the equipment racks:

2. Antenna RF signal conduit must be at least 12 inches from all parallel power circuit conduit runs and may only cross these at right angles.

3. Video signal conduit must be at least 12 inches from all parallel power circuit conduit runs and may only cross these at right angles.

4. Plenum rated cable may be used for horizontal loudspeaker cable runs.

D. Equipment Racks: All electronic devices shall be mounted in the equipment racks as follows:

1. Use Black rust-inhibited torx head screws with isolating black washers.

2. AC Power shall enter the rack at the bottom and wire up the side of the rack opposite signal wiring. All AC Power cables (low or line voltage) shall be dressed away from signal cables.

3. All Power devices such as power panels, power sequencers, etc. shall be mounted at the bottom of the rack.

4. Power amplifiers shall be mounted near the top of the rack to chimney heat away from other electronic devices and to take advantage of rack space unreachable by users. As an alternate installation, power amplifiers can be located near the bottom of the racks between AC Power and lower level signal devices.

5. Segregate audio and video as much as possible.

6. Concentrate all devices requiring user operation between 62" AFF and 30" AFF.

7. Mount video monitors high in video racks where reach is not an issue.

8. Install RF devices such as Wireless microphone receivers and hearing assistance devices at the top of the rack.

9. Topmost rack device is the front illuminating rack light.

10. Avoid mounting relays, barrier strips, splitters, etc. on the back of a blank panel unless this panel is installed high or low in the rack. This is to avoid wasting the vertical space of the racks.

11. Interior rack illumination shall be installed in all racks and shall be operable at all times, not be powered by sequenced power.
12. Where possible, mount associated devices adjacent to each other. Selection switcher next to selectable devices, for example.

13. All racks shall have a locking rear door.

E. Wiring: All wiring shall be installed in strict accordance with broadcast standard practices. Use strip terminal blocks mounted on the back panel of the equipment rack. Cabling jacket color shall be connected to maintain a consistent identification of phasing.

F. Power: Power conduit to be separated from other conduits containing signal lines. Provide a permanent hard-wired connection between the equipment rack and AC power. Connect AC power to the equipment racks from junction boxes designated by the Constructor.

G. Fasteners, Hangers, Supports: Provide fasteners, supports and seismic restraints to adequately support the load as required by local building codes. Secure equipment rack to wall.

H. Markings: Permanently mark all connecters', cables, and cable terminations to indicate their function corresponding to the wiring diagram. All cable pairs shall be coded with permanently-attached numbers on the cable ends with consistent color-coded markings to indicate their function.

I. Ventilation: Provide adequate ventilation in equipment racks to conform with the equipment manufacturer's temperature rise requirements or 20 degrees C.

3.05 Connections:

A. Connectors:

1. Audio: All connections to screw clamp or binding post terminals require flanged or snap spade type lugs appropriately color coded. Bare wire connected to a binding post is not acceptable. Loudspeaker connections shall be soldered with rosin core solder or with connectors approved by the Design Consultant. Insulation displacement "punch-down blocks" are acceptable terminal connections for microphone and line level interconnections.

2. Video: All co-axial cable connections shall be made with crimp type connectors for both shield and inner conductor installed with manufacturer's approved assembly methods and tools. Connectors attached to the co-axial cable shall be Type BNC with a BNC to UHF adapter or BNC or RCA adapter as appropriate for the equipment being connected.

B. Grounding: Use the rack as a common point of grounding all audio and video systems; the rack is to be grounded to earth. Cable shields shall only be used for shielding and connected to ground at the rack. Cable shields shall be connected to ground at the rack only. All rack-mounted equipment shall be checked for ground continuity between chassis and the rack.

C. Cabling:

1. All audiovisual cabling is to be continuous and un-spliced. Install signal separately from all power lines.

2. Permanently label all cabling and terminal blocks. Provide "run sheets" listing all sires by number, signal type, and both terminations. All wires shall have unique numbers.

3. Use strip terminal blocks mounted in the equipment rack.

4. Cables within racks shall be bundled and laced neatly to support members and maintain convenient access to all equipment connections.

5. AC power to the power strips in the rack shall be run in steel conduit.
6. AC outlets within the rack shall be grounded to earth.

7. Cables identified in the drawings as connecting to ‘future’ equipment shall be installed (with appropriate connectors or terminals) and routed as if the equipment were in place, with the ‘future’ destination end being labeled and tagged appropriately. Where receptacle plate, Custom panel or device is not available for connection, seal labeled connector in a plastic bag.

8. Route cabling between racks and consoles and between other separated items of equipment and terminal points to minimize mutual coupling between circuits.

9. Provide adequate service loops to allow equipment to be removed for maintenance or to extend equipment that is mounted in the rack on rack slides. Captive cables shall not be laced in such a manner as to prevent removal of the equipment to which they are captive. Where there is no rear access to the rack-mounted equipment, provide cabling of sufficient length to enable the removal and replacement of any individual piece of equipment without the necessity of the removal of other equipment.

10. For equipment utilizing slide assemblies for front extension while in operation, provide additional carefully dressed service loops on all cables to accommodate the full range of travel of the slides. This includes all power, ground, control and signal cables.

11. With the equipment rack environment, arrange cabling so that parallel cable runs are physically separated from each other by signal type. Maintain at least three (3) inches mutual separation between circuits carrying: a. Audio signals, b. Video signals, c. Control signals, d. RF signals, e. Data, f. Power wiring.

12. Where cabling carrying signals of differing types must cross, do so perpendicularly and return to specified separation in as short a duration as possible.

13. Support wire and cable by wireway, raceway system components, or lacing anchoring system. Except for the required service loops and cables entering into racks, no length of cable shall be unsupported for more than eighteen (18) inches.

14. Verify all connector details required for installation of equipment, including model and type, attachment configuration, tooling, pin-outs, and cable clamp accessories. Report inconsistencies to the Engineer for resolution.

15. Tin conductors, if necessary, with a minimum amount of 60-40 or 63-37 solder (tin-lead) with resin flux (manufactured by Kester, Ersin, or approved equal). Solder fillets shall wet and flow around conductor and terminal. In no case shall be general outline of the conductor be invisible in excessive solder. The insulation shall not be charred, melted, or burned by the soldering operation. There shall be no evidence of either lead or terminal contamination. The final solder joint shall be bright and shiny and shall show no evidence of being a "cold joint".

16. Use simple bends around solder eyelets and posts where mechanical connections need to be made to terminals prior to soldering. Do not use multiple wraps around solder terminals.

17. Insulation displacement connections shall only be installed with termination tooling as specified by the connector manufacturer. If shown in the connector manufacturer’s data, the controlled cycle crimp tool shall be selected. If the manufacturer has a multi-conductor mass-termination tool available, this shall be selected for all connectors of ten pins or more.

18. Individual conductors of cables installed on terminal blocks shall not be stripped, and shall be punched down with a spring-loaded impact tool designed for the purpose. Bare cable conductors shall be insulated with a Teflon or other insulation sleeve prior to being punched down on the terminal block. During the punch down process, sever the free end of the conductor; ascertain that this remnant is not left within the block or block assembly.

19. Bending Radius:
a. Do not subject copper cables to bending radius of less than ten (10) times the outer diameter of the cable jacket.

b. Do not subject fiber-optic cabling to bending radius of less than twenty (20) times the cable diameter during installation; bend radius when finally installed to be a minimum of ten (10) times cable diameter.

D. Cables and wiring in racks, consoles, connector boxes and on terminal strips shall be clearly marked between two (2) and four (4) inches from end of cable gasket/harness. Provide maximum label visibility. Indicate the circuit type, wire number, source and destination and jack, receptacle or socket to which connector should be mated. Use appropriate diameter clear shrink tubing over surface of label for protection and permanence. Extend shrink tubing over label by approximately 1/4 inch each end.

1. When holding any cable in installer's right hand with connector end of cable extending to installer's left hand, the installed cable label must read correct side up.

E. Label all devices including switches, control panels, monitors and camera control equipment. Label to be logical and permanent with clarity and legibility. Submit samples for approval.

F. Video Equipment:

1. Mount video wall display as shown on the drawings and adjust to maximize image brightness, size and image clarity. Mount Audio/video receptacle plates as shown on architectural drawings and coordinate with casework.

2. Terminate all unused 75 ohm outputs with 75 ohm loads.

G. Audio Wiring:

1. Maintain appropriate audio phasing and channels throughout entire system.

2. For unbalanced audio connections, use Belden 9451 (or approved equivalent). Attach low side wire (black) to shield at both ends to avoid induced signals in unused wire.

   a. When attaching active balanced signals to unbalanced inputs as in VHS duplication racks, attach the high side of DA signal to the high side of machine input. Leave low side of DA detached. Attach black wire and shield of cable to DA shield connection.

3. Where there are unused conductors or pairs in a cable assembly, insulate as a group, leave long enough for future termination, and fold into the connector hood. Where impractical, fold back along the outer jacket of the cable and cover with heat-shrinking tubing.

4. Where jumpers are indicated between pins of the same connector, install internal to the connector shell.

5. Strip conductors prior to installation underneath screws on terminal.

   a. For stranded conductor wire, use insulated crimp spade terminals for application to barrier strips. Multiple gang lugs or ring lugs are not acceptable for this purpose.

6. Attach solid conductors directly to the barrier strips.

7. Wrap screw terminated solid conductors in the same direction as screw rotation during tightening.

8. Connect shield of balanced line level audio signals at signal source and leave the shield unconnected at destination connector.

9. At patch panels: Leave unconnected the source cable shield; tie destination cable shield to
technical ground at patch panel block. Do not normal through shield at jack field. Tie patch panel
ground terminals to cabinet technical ground with No. 10 stranded THHN wire.

10. Audio shield is not to be connected to audio signal receptacles originating or terminating at remote
classrooms. Those signal shields should be grounded at the patch panel.

11. Unbalanced signals must connect to specified balancing amplifiers with shortest practical cable
length.

12. Open-ended grounding procedure herein listed is essential to limit the possibilities of ground loops
but is vulnerable in some cases to high RF signal levels. If objectionable, RF ground at the open
shield and by connecting a 0.01 uf high quality disc ceramic capacitor (such as Erie Red Cap or
other monolithic type) between the open shield wire and the chassis ground.

13. Loudspeakers:
   a. Install loudspeakers as required by the specification.
   b. Provide or coordinate all structural support, guy wires, framing and similar as required for
      proper support of ceiling mounted loudspeakers.
   c. Provide or coordinate all structural support, framing and similar as required for proper
      support and orientation of wall mounted loudspeakers.
   d. All loudspeakers shall be wired in positive phase.
   e. Wire loudspeakers and adjust loudspeaker transformer taps to meet the specifications.
   f. Verify loudspeaker polarity by checking that positive voltages result in positive
displacement of loudspeakers.

H. AC Power will be provided to the equipment racks in control rooms. The audiovisual contractor is to terminate the
AC power through remote controlled receptacles with all power wiring being installed in conduit. Power provisions
are as follows: one circuit to each of the control console equipment racks, two circuits to each of the upright racks
in the video control room.

   1. A remote AC Power controller and the CPU for the audiovisual remote control systems will be on
      an always active circuit located in the console. One always active circuit will also be located in
      each of the upright racks.
   2. When start-up signal is provided by operation of the power-up controller, the controller will step
      through a power-up sequence. All audio and video devices will be turned on sequentially to prevent
      power line surge. The audio power amplifiers will be last to power-up to prevent turn-on transients
      from damaging loudspeakers.

3.06 Performance Specification:

A. General Performance Specifications:
   1. Ensure that all equipment is installed, connected and adjusted in compliance with manufacturer's
      specifications.
   2. Furnish all equipment and personnel to conduct these tests in accordance with the performance
      specification requirements. ANSI S1.13 and EIA Standards RS-160, RS-219 and R8-189A shall
      apply.

B. Audio Performance Specifications
   1. The sound pressure level spectrum, from the program speaker system, in each 1/3 octave band
shall be ±3 dB from 100 to 15 kHz with no greater than 2% acoustical total harmonic distortion at sound levels of 90 dBC at 4 feet above finish floor.

2. The sound pressure level spectrum, from the speech reinforcement system, in each 1/3 octave band shall be ±3 dB from 100 to 10 kHz with no greater than 2% acoustical total harmonic distortion at sound levels of 85 dBC at 4 feet above finish floor.

3. Signal-to-Noise Ratio including cross talk: -52 dB or better.

4. The standard audio signal level for this facility is +4dBu

\[ O_v = 20 \log_v 0.7746 \]

5. An audio tone of +4dBu should produce a 0VU reading on all properly calibrated balanced signal meters specified in this system. Equipment with unbalanced inputs used in this system will display 0VU with an input of approximately -7dBu. Line matching amplifiers must be adjusted for proper display and absence of distortion on these "semi-pro" devices.

6. Set standard audio line level for interface between equipment in this system and to external systems to +4dBu.

7. Ensure that load input impedance is either higher than or matches source equipment output impedance. Do not connect load to source equipment where input impedance of the former is lower than the output impedance of the latter. Report such instances.

8. Outputs of semi-professional equipment which typically cannot adequately drive a matched load. In this case, suitable buffering equipment shall be supplied to meet the output requirements.

C. Video Performance Specifications:

1. Provide Field Strength Meter readings at all MATV television receptacles.

2. Co-Axial Terminations:

   a. Furnish factory-manufactured, co-axial terminators (value 75-ohms ±0.1 percent), as required, for each video equipment item having looping (bridging) inputs, irrespective of whether equipment is self-terminating or is provided with terminating switch. Set terminating switches to OFF.

   b. Assure 75-ohm termination of all video, synchronizing and pulse cables either within the item of equipment being served or externally.

   c. Submit sample terminator for approval prior to installation.

3.07 Contractor’s Testing:

A. Copper Cable testing: Testing of all copper wiring shall be performed prior to system checkout. 100 percent of the horizontal and riser wiring types shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage. Control and data horizontal wiring pairs shall be tested from the information outlet to the TC. The Category 5 cable runs shall be tested for conformance to the specifications of EIA/TIA 568A Category 5. Testing shall be done with a TIA/EIA TSB-67 UL Certified Level 2 test set. Test shall include length, mutual capacitance, characteristic impedance, attenuation, and near-end and far end crosstalk. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor, at no charge to General Contractor or the Owner. Complete, end to end test results must be submitted to General Contractor or to the Owner before acceptance testing. Failure to provide testing results can defer acceptance testing and payment.

B. Audio Cable testing: Test all microphone and line level wiring for polarity, line loss, resistance and proper termination with respect to labeling. Provide numerical test results (not testing technicians initials). Test all loudspeaker circuits for phase and termination. Provide measurements of loudspeaker loads without the power
amplifier connected. Measured loudspeaker loads should test within 10% of calculated loading.

C. Audio Testing Procedures:

1. Initially adjust all system gain controls for optimum signal-to-noise ratio. After all adjustments required to meet specification requirements are made, measure and report the resulting system electrical signal-to-noise ratio at the amplifier outputs from 20-20 kHz in 1/3 octave bands referenced to the voltage required to achieve 85 dBC sound pressure level at 4 feet above finish floor.

2. Measure 70 volt loudspeaker/auto-transformer line impedance at the equipment rack with all loudspeakers connected and the amplifiers disconnected. Report the absolute value at 1 kHz for each loudspeaker zone.

3. Coverage Uniformity: Scan the areas served by the system and record sound pressure level in 1/3 octave bands. Perform any necessary adjustments to loudspeaker orientations as required to achieve the specified uniformity.

D. Test Reports:

1. Test Plan and Forms: Submit complete test plans for all tests specified and all tests required to demonstrate compliance.

2. Submit preliminary test results, including impedance reports and continuity test reports as required in order to initiate acceptance testing.


3.08 Contractor's System Adjustment:

A. Adjust controls and ensure that all equipment is installed in compliance with manufacturer's specifications.

B. Electronic Audio Equipment Adjustment:

1. Adjust the gain structure for all audio system components (mixer input to amplifier output) to achieve the highest signal-to-noise ratio, which shall be greater than 55 dB from 50 Hz to 15 kHz.

2. The audio frequency response of the playback audio system with equalizers bypassed shall vary less than ±1 dB from 50 Hz to 12 kHz.

3. Total harmonic audio distortion shall be less than 1% at 1kHz at the equipment's rated input signal level.

4. Adjust the speech reinforcement equalizer to roll off the low end of the audio spectrum 3dB per Octave from 200 Hz down. Adjust the high end audio spectrum to roll off 3dB per Octave from 7 kHz. Use the remaining notches for gain-before feedback notching.

C. Report: Prepare and submit a letter/report documenting the results of these preliminary tests including final equalizer and amplifier settings.

3.09 Acceptance:

A. Qualification for Acceptance: Subsequent to completing preliminary testing, the Audio Video Contractor shall furnish the Authority with two copies of "as-built" wiring diagrams of the entire system including the connection numbers and their locations along with cable color coding and gain settings in a written report. Then the Audio Video Contractor shall notify the Authority in writing that the installation is complete and conforms with this specification and is ready to be reviewed and tested.
B. Acceptance Test: The Authority's representative will be present during the acceptance testing and require the assistance and cooperation of the Audio Video Contractor.

1. Each major component shall be demonstrated to function.

2. Measurements: Further electrical, optical and acoustical measurements may be performed at the discretion of the Authority and/or their representatives. Acoustical measuring equipment will be supplied by testing representative. Such measurements may include sound pressure levels, uniformity of coverage, distortion, or other pertinent characteristics. The Audio Video Contractor shall provide equipment for performing any necessary electrical test or adjustments including equalizer programming unit with display capabilities of all band information simultaneously.

3. Viewing and listening tests may include subjective tests by observers at any location in the facility.

4. Operating tests may include use of any individual or combination of systems provided and from any control location.

C. Such tests may be performed on any piece of equipment or system. If any test shows the equipment or system is defective or does not comply with the specifications, the Audio Video Contractor shall perform any remedies at his expense and pay the subsequent expenses of any re-testing required.

D. The Audio Video Contractor is to provide a final letter/report which will document the final gain settings. All final settings and adjustment notes shall be included in the final system documentation manual.

E. Written Test Results: All fiber and copper wires shall be tested with numerical test results provided. Sign-offs are not test results. Numerical test results shall be provided in dBu loss for each signal type tested.

3.10 Manuals and Documentation:

A. Documents of Record: Provide as required.

1. Manual shall be divided into two sections: Operations and Maintenance.
   a. Operations Section is a compendium of operations sheets. Each room type is to have a one page operations sheet "ProVidea list of custom-written Short-form Operating Instruction Sheets, .and an outline for each.
   b. Maintenance Section contains all product documents, such as those provided by manufacturers. This section also contains drafted CAD documents including functional diagrams, plans showing floor plan, reflected ceiling plans and custom fabrications:

2. Binding and Organization:
   a. One set of Manuals for onsite use: Three-ring binders.
   b. One set of Manuals for office use: Bound books suitable for filing and photocopying.
   c. One set of Manuals for backup file: flat file binders or bound books.
   d. Label front covers and spines by silk-screening, printed insert behind clear plastic, or other approved method.

3. Content: As a separate manual for each system, include the following:
   a. Include all work installed under addenda or change orders.
   b. Updated equipment list including serial number of each item. List loose items separately.
c. A copy of all product data submittals in their final approval form.

d. Recorded test data, including final equalization settings, internal and fixed control settings, and signal delay and processor settings.

e. Record drawings including complete block diagrams, and point-to-point wiring diagrams showing number or color coding and schematics of custom assemblies.

f. Copies of all manufacturers' warranties.

g. Names, address(s), and business telephone number(s) of installing Audio Video Contractor. Include instructions for obtaining service of the systems during and after the warranty period.

3.11 Training:

A. Operation and Maintenance Manuals, As-built functional diagrams, Training Manuals, and all other necessary documents shall be provided to all students for the training sessions.

3.12 Final Notification:

A. At the completion of the System, the Contractor shall notify the General Contractor in writing of their readiness to test for Owner acceptance. The General Contractor will notify the Owner and the Owners Agent (Consultant) of the subcontractors readiness.

B. Qualification for Acceptance: The Contractor shall furnish the Owner with two copies of "as-built" wiring diagrams of the entire system including the connection numbers and their locations along with cable color coding in a written report. Then the Contractor shall notify the Owner in writing that the installation is complete and conforms with this specification.

C. Owner will operate and test installed systems. Any component device or wiring found deficient will be reported in written form. Contractor to adjust as required.

D. Retention shall be paid according to the requirements of the contract documents.

3.13 Warranty:

A. Installation Contractor Warranty

1. Contractor shall provide a one (1) year warranty. This warranty is to cover installed devices, wiring, terminations, and adjustments. This warranty is not to cover vandalism, mischief, Owner or user misuse, or subsequent activities out of the control of the installing contractor.

2. Warranty period shall begin upon formal acceptance following execution and acceptance of all punch list items.

B. Manufacturer Warranty

1. Standard products provided and installed by subcontractors shall be enforceable for the length of that warranty. If the extended specialty warranty is beyond the one year contractor warranty, full contact information and warranty terms must be provided to the Owner. This information shall be provided as part of the Owners manuals. The installing contractor will serve as the agent for these warranty returns.

C. Specialty Products Warranty
1. Specialty products and systems installed by subcontracted vertical integrators that have Extended Product Warranty and System Assurance Warrantees shall be enforceable for the length of that warranty. If the extended specialty warranty is beyond the one year contractor warranty, full contact information and warranty terms must be provided to the Owner. This information shall be provided as part of the Owner’s manuals. The contractor shall also send a reminder letter at the end of their warranty obligation reminding the Owner of the extended warranty. This letter is to also provide updated (if revised) contact information and the devices or systems covered by this warranty.

D. Additional Warranty

1. Contractor shall state any additional Contractor supplied warranty.

END OF SECTION
SECTION 13700
SECURITY GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 Work Required By Contract Documents

A. Provide all labor, materials, equipment, tools, transportation, insurance, and service for a complete, operational extension to the existing Security System.

B. Related Sections:
   1. Division 1, General Requirements
   2. Section 13710, Access Control Systems
   3. Section 13730, Closed Circuit Television System
   4. Division 16, Electrical
   5. Section 16800, Security Electrical

1.02 Definitions:

A. University: California State University at Monterey Bay (CSUMB) shall be referred to throughout this document as the University (including direct employees and other appointed University agents such as architects and engineers. These agents may be requested by the University to represent the University in undertaking certain project tasks).

B. Contractor: Individual or company contracted to provide the system(s) as described in these specifications.

C. Project Record Drawings: Drawings that completely record and document all aspects and features of the project (also known as “as-built” drawings)

D. System Documentation: A complete collection of all installation, programming, operations, maintenance manuals, and work sheets relating to the equipment provided as part of the project.

E. Subcontractor: A person or entity that has a direct contract with the Contractor to perform any work at the site.

F. Construction Aids: Facilities and equipment required by personnel to assist in the execution of the work (construction aids include, but are not limited to: scaffolds, staging, ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, and protective equipment)

1.03 Abbreviations:

A. The following abbreviations may be used in this document:
   
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Acrylic Butyl-nitrile Styrene</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>ACP</td>
<td>Access Control Panel (Card Access)</td>
</tr>
<tr>
<td>AMP</td>
<td>Amperage</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AHJ</td>
<td>Authority Having Jurisdiction</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society of Tool Manufacturers</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge</td>
</tr>
</tbody>
</table>

CSUMB Tanimura & Antle Family Memorial Library
Third Floor Build Out

100% Construction Documents
03/26/12
SECURITY GENERAL REQUIREMENTS
13700 - 1
1.04 Drawings and Specifications:

A. The written Technical Specifications and Security Drawings comprise the complete security system specifications.
as desired by the University.

B. Statements made in the Technical Specifications and not reflected on the Security Drawings, or conditions shown on the Drawings and not stated in the Specifications shall, in effect, be considered to be shown or stated in both. In the case of conflicting information between Drawings and Specifications, the Contractor shall notify the University in writing of all conflicts and request clarification prior to the purchase or installation of any equipment. The University’s Representative shall provide clarification in writing.

C. The Security Drawings are accurate as to available information as of the release date; however, due to the possibility of changing site or architectural conditions, the Contractor shall identify those exceptions and changes that may affect the bid response. If no exceptions or changes are presented, the Contractor shall become responsible for any changes to the work required as a consequence of such pre-existing conditions.

D. The Drawings and Specifications are for the assistance and guidance of the Contractor; exact locations, distances, elevations, etc., shall be governed by actual field conditions.

   1. For purposes of precise building dimensions, the Architectural Drawings take precedence over the Security Drawings.

E. Architectural floor plans, door hardware schedules, electrical drawings, and/or inter-building cable plans may contain additional information pertaining to the security system and are available from the University’s Representative. However, security system specifications shall take precedence over architectural and electrical drawings for the location and type of security devices to be provided. The following list identifies specific drawing information:

   1. Architectural floor plans and/or door hardware schedules contain information on door type and hardware to be installed
   2. Electrical drawings contain power location information and may contain signal conduits.
   3. Security drawings may have duplicate or additional electrical information.

1.05 References and Regulatory Requirements:

A. All work shall conform to the latest edition (as to the date of these specifications) of all building, fire, and electrical codes and ordinances applicable to the project such as:

   1. NFPA 70 - National Electric Code
   2. NFPA 101 - Life safety Code
   3. The California Building and Electrical Code, Title 24
   4. American with Disabilities Act (ADA) - Public Law 101.3
   5. TIA/EIA 568 Commercial Building Telecommunications Cabling Standard
   6. UL 294 - Access Control Systems
   7. UL 1076 - Proprietary Burglar Alarm Units and Systems
   8. Any other Code referenced herein

B. Compliance with code shall be mandatory.

C. Work not conforming to the above referenced codes shall not be allowed under these drawings and specifications.
D. In case of conflict between the Drawings/Specifications and codes; the codes shall govern. (Notify Owner's Project Manager of any such conflicts.)

E. The Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. Any documents, including drawings, which may be required by the regulatory agency, shall be provided as part of the specified project.

F. The materials, wiring, and equipment shall be provided and installed in accordance with the best practices of the electrical and security industry.

1.06 Submittals:

A. Preliminary Submittals:

1. Prior to purchasing any equipment the Contractor shall submit, for acceptance by the University’s Representative per section 01330, the following:
   a. A material list with names of manufacturers, model numbers, and technical information on all equipment proposed for installation.
   b. Catalog cut sheets of the equipment to be installed
   c. A preliminary schedule based on installation events.

B. Project Record Drawings:

1. The purpose of Project Record Drawings is to provide factual information regarding all aspects of the project and to enable and support future service, modifications, and additions to the Security System.

2. The Project Record Drawings are an important element of this project. The Contractor shall accurately maintain the Project Record Drawings throughout the course of this project.

3. One (1) set of Security Drawings on electronic media and/or reproducible media may be requested in writing from TDA for Contractor use in developing submittals and Project Record Drawings. TDA will provide all drawings in AutoCAD® 2000 format unless another format is specifically requested. Additional sets may be obtained from TDA for a nominal fee.

4. An individual skilled in standard drawing practices shall produce the final set of Project Record Drawings.

5. One (1) week before the scheduled test and final acceptance of the work, the Contractor shall deliver one (1) complete set of Project Record Drawings (on Bond) and AutoCAD® drawing files in “DWG” or in “DXF” format on a CD-RW.

6. The Project Record Drawings shall, at a minimum, include the following:
   a. Floor plan drawings indicating wire routing (wire routing shall be delineated in straight-line runs and be tagged with cable identification and terminal strip numbers to coincide with the installation).
   b. Floor plan drawings indicating device locations to include any existing equipment, wiring, conduits, and raceways that were reused in this project with device legends.
   c. Functional one-line diagrams for each subsystem.
   d. Wiring details showing rack elevations, equipment wiring and terminations, and inter-rack Wiring.
e. Wiring diagrams for all custom circuitry including interfaces to various output controlled devices (i.e., overhead doors, sliding doors, parking gate operators, fire alarm system interface, etc.)

f. Typical point-to-point wiring diagrams with wire color for each piece/group of equipment within the system.

g. Layout details for each riser location - including security panels, PSs, J-Boxes, conduit, and any other security-related equipment located in the riser.

C. System Documentation:

1. The System Documentation shall be compiled into a binder, or set of binders, with easy identification as to its contents. Each binder shall be organized into tabbed sections. There shall be a master index identifying the contents of each binder and section.

2. The Contractor shall also deliver (along with the Project Record Drawings) the System Documentation Manuals to the University, including the individual factory-issued manuals containing all technical information on each piece of equipment installed.

3. The System Documentation Manuals shall include, at a minimum:

   a. An operational description of each subsystem.

   b. Detailed programming descriptions for each subsystem, including step-by-step procedures, with illustrations identifying how computer screens will look after each entry.

   c. Explanations of subsystem interrelationships, including operations of each subsystem, operations unique to the interfaces between each of the Subsystems, and possible conflicts that may occur with the interface (each explanation shall be identified, tagged, bound, and indexed into a single binder).

   d. Electrical schematics for each piece of equipment furnished

   e. Power-up and power-down procedures for each subsystem

   f. A description of all diagnostic procedures.

   g. A menu tree for each subsystem providing a graphical flow of commands within the menu system.

   h. Setup procedures for each component of the subsystems.

   i. A list of manufacturers, their local representatives, and subcontractors that have performed work on the project (include contact names, phone numbers, and addresses for each)

   j. Installation and service manuals for each piece of equipment.

   k. Maintenance schedules for all installed components, including inspections and preventative maintenance schedules, and documentation of all repaired or replaced equipment.

   l. Descriptions of all software, their terms and functions, as well as required sequences.

   m. A directory of all disk files.

   n. A description of all communications protocols including data formats, command characters, and a sample of each type of data transfer.
Instructions for manufacturer-supplied report generation, with illustrations showing how reports should look, and screen-by-screen illustrations for each entry made.

Instructions for custom report generation.

Database format and data entry requirements.

1.07 Quality Assurance:

A. General:

1. The equipment herein specified shall be Contractor-supplied, interconnected, installed, and tested, utilizing qualified and capable manufacturers’ certified technicians.

2. All incidental work (including but not limited to cutting and patching, locking hardware installation, painting, and carpentry) shall be accomplished by skilled craftsmen regularly engaged in such work. All such work shall comply with the highest standards applicable to that respective industry or craft.

3. All 120VAC-power wiring and connections shall be performed by a qualified Journeyman Wireman licensed to perform such work at the project location.

B. Contractor Requirements:

1. Maintain the appropriate Contractor’s and other licenses required to perform the type of work stipulated by this specification in the state and community in which the project is located.

2. Be a certified dealer of the specified equipment, with proven experience in comparable installations of this size, type, and scope within the last five (5) years. (A list of those installations, including contact name and phone numbers, shall be submitted to the University upon request.)

3. Employ factory-trained personnel in the installation, operation, and maintenance of the subsystems. At least one (1) member of the installation team shall have a minimum of two (2) years experience in the installation, operation, and maintenance of the access control system to be provided.

4. Provide qualified electronic technicians (as described above) to hook up, program, and test final termination Journeyman electrical workers may be used to install conduit, raceways, and wiring). All such work shall be supervised by the Contractor’s Project Manager.

5. Provide twenty-four- (24-) hour support services from an existing operations center within fifty (50) driving miles of the University’s Facility.

6. Provide emergency service within four (4) hours of notification.

7. Provide factory-trained service personnel who are dedicated to the University’s account. Any changes in personnel shall be approved by the University prior to any new service technician’s work on the account. (All costs for assigned service technicians shall be included in the contract price.)

8. Have the capability to perform system testing and provide instruction on the use and operation of all elements of the Subsystems and their interconnections.

9. Provide qualified instructors to conduct factory system training.

10. Maintain an inventory of spare parts and other items critical to the system operation (and as necessary to meet emergency service requirements of this project) within the local service center to allow for minimal downtime of critical elements of the University’s security System.

11. Provide local in-house engineering and project management capabilities consistent with the
requirements of this project.

12. Provide a full-time project manager who shall be present while the work is actively in progress, and who shall be the same individual throughout the course of the project. This Project Manager shall be responsible for system programming, preparation of Operation and Maintenance Manuals, training programs and schedules, test protocols, documentation of system testing, maintenance of Record Drawings, and coordination and scheduling of all subcontract labor. (the University reserves the right to approve the Contractor's project manager.)

13. In the event the Contractor becomes unable to complete the work in accordance with the contract documents or to the satisfaction of the University due to a lack of understanding of equipment, systems or services required by the contract documents, it shall be the responsibility of the Contractor to retain the services of the applicable manufacturers' representatives or other qualified contractor to expeditiously complete the work in accordance with the construction schedule (With no additional cost to the University).

C. Product:

1. All components provided for the security System shall be of standard manufacture to ensure continuous availability of parts and trained technical support.

2. Where "or approved equivalent" is indicated, the Contractor may submit to the University a proposal to substitute manufacturers and models that may be more cost-effective or readily available than that specified and still meet the performance, appearance, and cost requirements of the specified equipment. All substitutions shall meet or exceed the minimum functional and technical specifications. A request for substitution shall be submitted as follows:
   a. In writing
   b. Be received by the University at least five (5) days prior to bid open
   c. Clearly identify product and model number of proposed substitution
   d. Include sufficient data to allow the University to evaluate suitability of proposed product.
   e. Include acknowledgement that the contractor assumes responsibility for capacity, dimensions, performance, etc.

3. Where "no approved equivalent" is indicated, it has been determined that there is no other product that meets the performance, appearance, and cost requirements of the selected product within the specified design, or the University has unequivocally requested the specified product.

4. The Contractor shall perform a complete system test and resolve any system deficiencies prior to the Final Acceptance Test by the University or University. This test shall be performed at the operational location and under normal operational environmental conditions. All test and report costs shall be included in the contract price. A checkout report shall be prepared by the technician and submitted in triplicate to the University one (1) week prior to the date of the scheduled Final Acceptance Test and acceptance of work. The report shall include but not be limited to:
   a. A complete list of equipment installed and wired.
   b. Indication that all equipment is properly installed and operates in conformance with these Specifications.
   c. Tests of individual units, as applicable.
   d. Technician's name and date.
1.08 Project/Site Use and Conditions:

A. The Contractor shall become familiar with all aspects of the project.

B. Construction Aids:
   1. The Contractor shall provide all Construction Aids required in the execution of the work. Construction Aids that are the property of the University or other contractors shall not be used without permission.
   2. Storage of Construction Aids shall be coordinated with the University's on-site representative.

C. Safety:
   1. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the work.
   2. The Contractor shall comply with all local, state, and federal regulations and laws for the safety of the workplace.

1.09 Warranties:

A. The entire system, including parts and labor, shall be under warranty for a minimum period of one (1) year from the date of substantial completion of the project.

   1. The acceptance test and commissioning report shall annotate the warranty commencement date.
   2. This warranty shall supersede any contractor's standard warranty of a lesser period.
   3. The warranty shall include, to the original purchaser:
      a. All products as herein specified, including software, shall be free of defects in material or workmanship at time of installation completion.
      b. Onsite labor to troubleshoot the installed security system components when problems occur within the system.
      c. Labor and materials to repair and/or replace Installed equipment, software, and wiring found to be defective.
         (1) Warranty service shall be provided twenty-four (24) hours per day, seven (7) days a week, at no additional cost to the University.
      d. Software updates issued by the manufacturer to correct discovered defects within their software.
      e. Any manufacturer's warranties less than the one- (1-) year period herein specified shall be extended to the one- (1-) year minimum period.
      f. Any manufacturer's warranties that extend beyond the one- (1-) year period herein specified shall remain in effect until the expiration of that specific warranty.

   4. The Contractor as well as the Licensor of any hardware, firmware, or application software product (and/or services provided for any part of the Security System) shall warrant that the hardware, firmware, software and/or services provided:
      a. Are designed to be used during and after the current calendar year (as shown on this specification).
b. Shall continue to function fully during and after the current calendar year (including leap year calculations) without interruption.

c. (If applicable) Shall have full capability to accurately and unambiguously process, display, compare, calculate, manipulate, and otherwise utilize date information.

d. Shall operate during each time period without error or interruption of date data, specifically including any error relating to or the product of date data representing or referencing different or multiple centuries.

5. Not included under this warranty:

a. Product(s) provided and installed by others, that are part of the security system.

b. Existing product(s) installed prior to this project, of which this project may be an expansion.

c. Labor to troubleshoot product(s) identified in paragraphs 1.09.A.4.a & b above.

(1) If a system malfunction is reported wherein the Contractor is called to troubleshoot, and the problem is discovered to be in product not provided under the Contractor’s scope of work in this project, the Contractor may charge the University the technician’s prevailing or pre-established labor rates.

(2) As soon as it is discovered that a reported malfunction is caused by a product not provided as part of the Contractor’s scope of work in this project the technician shall notify the University of the findings, costs (if any) incurred up to that point, and recommendations to correct the malfunction and associated costs.

d. Labor to perform the scheduled maintenance.

B. System Stability Period:

1. The purpose of the System Stability Period is to insure continued system operation without problems by:

   a. Monitoring system operation and malfunctions, if any.

   b. Performing any system "tweaking" that may be required.

   c. Identifying recurring security system problems that may be related to, but not limited to, a product design defect, system defect, wiring defect, or installation defect.

   d. Maintaining a log of all system problems reported during the stability period.
2. The first ninety (90) days of the warranty period shall be considered a system stability period, which may be extended until all malfunction(s) have been resolved to the satisfaction of the University.

3. Should a problem occur within the security system, the Contractor shall readjust repair or replace the defective components in an appropriate fashion (as described in paragraphs 1.8.C below) under the scope of this warranty.

4. After a problem has been corrected the ninety- (90-) day stability period shall restart.

5. After the first six (6) months of the warranty period, if the system is still being monitored in a "ninety- (90-) day stability period", a review of the system problems shall be conducted with the University with recommendations on how the problems may be resolved.

6. University with recommendations on how the problems may be resolved. If the requirements provided in the paragraph above are not completed within the one- (1-) year warranty period, the Contractor shall replace the faulty system component(s) (which may include the replacement of access control panels and software) through another acceptable manufacturer and repeat the process until a ninety- (90-) day period without problems on the defective components can be achieved.

C. Service Call Response Requirements

1. Upon notification by the University of a malfunction within the system, the Contractor shall provide a qualified repair technician on-site within four (4) hours of such notification.

2. The Contractor shall provide the University with a twenty-four- (24-) hour telephone number (including weekends and holidays) for the purpose of such notification.

3. Major subsystem elements, and their subcomponents found to be faulty, shall be repaired or replaced within three (3) consecutive days.

4. The Contractor's technician shall provide the on-site University's Representative with a verbal status report at the time service is rendered.

5. In addition, the technician shall provide a brief written report describing the problem, what work was completed, what work (if any) needs to be completed, and the date the technician will be returning to complete the project.

6. The Contractor shall provide a written closeout report indicating the cause of the malfunction, corrective action taken, and system status at the completion of the repair work, to the University within three (3) working days "after completion of the repair.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION
SECTION 13710
ACCESS CONTROL AND ALARM SYSTEM

PART 1 – GENERAL

1.01 Summary

A. Section includes: An access with alarm monitoring system expansion, complete including the following:

1. Card Readers
2. Passive Infrared Exit Detector
3. Door Alarm Contacts
4. Local Sounder
5. Installation of equipment
6. All related wire, cable, fittings, adapters, key-operated enclosures, and necessary System configuration and programming.

B. Related Sections and drawings:

1. Section 13700
2. Section 08110 - Metal Door and Frame
3. Section 08310 - Access Doors and Frames
4. Section 08710 - Finish Hardware
5. Section 08730 - Automatic Door Operators
6. Division 16 – Electrical and Telecom
7. Section 16800 - Security Electrical
8. Architectural Drawings
9. Security Drawing

1.02 Products Installed But Not Furnished Under This Section:

A. Power, Conduit, Backboards
B. Doors and door frames
C. ELH and door power-assist mechanisms
D. Network Data Cabling

1.03 Design Requirements:
A. Add access control and alarm devices consisting of standard "off-the-shelf components, which shall connect to an existing HID Edge Plus security system to provide access control, intrusion detection, and alarm monitoring via Local Area Network, and provide a CSC to communicate designated alarm signals to off-site Central Station alarm monitoring facility.

B. Card access and secondary fire signals shall be monitored and managed from the University's SOC.

C. Alarms shall be monitored and managed from the University's SOC and monitored at an off campus Central Station alarm monitoring Facility.

D. Provide door control and report access to the University's building by means of card-access-control with the following features:
   1. An authorized access card with a unique 10 number and system code.
   2. Access granted only by an authorized card and the system code and ID number on the card is found in the ACP memory, and it is authorized for that CR location for the current time period which shall cause the ELH to unlock.
   3. Access not granted if the card is not authorized.
   4. All card activity recorded on the server for report generation.

E. On ADA doors with power assist a valid card read shall unlock the door and enable the ADA push button for entry.

F. Edge Readers shall:
   1. Communicate with the system server via University provided network.
   2. Be configured with one (1) reader boards.
   3. Support distributed access control processing.
   4. Be capable of full operation when not connected to the system server
   5. Have battery backup via PoE switch and shall remain operable, in case of a commercial power outage.

G. The Intrusion Detection shall:
   1. Be part of the access control system
   2. Use end-of-line resistors at the alarm device
   3. Communicate alarm signals to the server via the ACP
   4. Communicate alarms to the Central Station monitoring facility
   5. Store alarm events in the ACP in the event of a communications failure between the ACP and the server
   6. Incorporate UL-Listed alarm device(s)
   7. Detect and report unauthorized entry or exit through doors provided with MCs during nonscheduled hours (and activate a dedicated LS)
8. Report the alarm activation a door contact via one set of the DPDT contact switch to the University’s SOC and the other set to the Central Station monitoring facility.

9. Report the alarmed activation of any GB to Central Station monitoring facility.

H. Based upon a University developed time schedule, the access control system shall unlock all ELHs in the building and shall also simultaneously disarm the CSC.

I. Arming the CSC alarm system will be typically be done by using the CSC keypad.

J. When entering the facility after the system has been armed will require a valid card read and then disarming the alarm system at the keypad.

K. All equipment enclosures shall be keyed alike and be keyed to ES201 key.

PART 2 – PRODUCTS

2.01 General

A. Furnish and install (at locations shown on the Security drawings) the specified equipment to provide a completely operational Security System. However, the following subsystem items to be provided for installation shall not be considered all-inclusive:

B. All products not provided by The University shall be new and of manufacturer's current and standard production.

C. Drawings and Specifications indicate major system components and may not show every component, connector, module, or accessory that may be required to support the operation specified. The Contractor shall provide all components needed for complete and satisfactory operation.

2.02 Product Availability:

A. Prior to submitting a proposal, product availability and delivery time shall be determined and such considerations shall be calculated in the proposed Contract Time.

B. Certain specified products may only be available through factory-authorized dealers and distributors. The ability to procure the products specified shall be verified prior to submitting a proposal.

2.03 Access Control:

A. Card Reader:
   1. HID Edge R40 Card Reader; no approved equivalent
   2. The CRs shall provide the following visual indications:
      a. Card was read
      b. Card was authorized and door unlocked
      c. Access was denied
      d. Reader tamper was activated (switch selectable)
      e. Communications were disrupted (switch selectable)

B. Request to Exit Device:
1. Detection Systems model DS150i; or approved equivalent
2. Uses passive infrared technology to detect persons passing through its field of view
3. Has a detection pattern large enough to assure activation of the MC shunt circuitry at the SEP prior to door opening (yet adequately limited in size to keep erroneous activation to a minimum)
4. Provided with two (2) form "C" contacts
5. Wall and ceiling mountable
6. Internal, vertical point ability
7. Up to sixty- (60-) second adjustable latch time
8. Selectable relay trigger mode
9. Selectable fail safe/fail secure mode
10. Color. To be selected by University Representative
11. 12 or 24 AC or DC Operation
12. UL-Listed

C. Magnetic Door Contact:
1. Sentrol model 1076D (flush) or 2507AD (surface) MC; or approved equivalent
2. DPDT hermetically-sealed, magnetic reed-switch
3. Reed-potted in contact housing, with a polyurethane-base compound
4. Snap-lock housing into a 15/16" diameter hole (flush mount)
5. Molded of aflame-retardant ABS plastic
6. Color to match the doorframe in which it is mounted.

D. Local Sounder:
1. Designed Security, Inc. model ES4300-K4 Local Sounder, RIM without cylinder; or approved equivalent
2. normally-closed dry-output contact
   a. contact activates immediately upon receipt of an open-circuit message from the interconnected MCs
3. internal sounder
   a. activates simultaneously with the output contact
   b. annunciates for twenty to thirty (20-30) seconds after the MC has reset
4. Accepts RIM cylinder
5. Multi-function key switch
a. Silences (disables) the internal sounder
b. Shunts the output contact
c. Opens a contact for monitoring the key switch position

6. Internal tamper switch
7. Mounts to 3 gang, 2.5” deep electrical box
8. Color to match surrounding area

E. Power Supply 24VDC:
1. Alarm-Saf model ASIPLS-24050.B04-UL; or approved equivalent
2. Provides a minimum of eight (8) hours on standby battery during commercial power outage
3. Provides one (1) or more 24VDC outputs with a maximum of 2.5 amps for each output
4. UL-Listed
5. Be keyed-alike with other Access Control Subsystem enclosure

F. Security Equipment Panel:
1. Genetec HID Edge;
2. Provides distributive process, decision-making capabilities for a maximum of one (1), card-reader addresses
3. Communicates with the Host Computer for the purpose of receiving updated data, and transmitting Intrusion Detection status-change information.
4. Communicates with CRs for the purpose of receiving reader-transmitted card-read data, and comparing that data against existing, on-board files, to decide whether entry should be granted or denied
5. Capable of monitoring and supervising non CR-related alarm-inputs and of controlling multiple TIL and Relay-level outputs
6. Has the capacity to hold up to thirty thousand (30,000) card codes within on-board memory
7. Configured with 12VDC power supply with sufficient battery backup to support full SEP operations for not less than eight (8) hours during a commercial power outage
8. Capable of making access and rejection decisions locally, based upon card data within on-board files
9. Capable of storing a minimum of 2048 transactions and/or status changes during a communications failure between a SEP and the Host Computer
10. Incorporates the use of “FLASH ROM” to allow capability of upgrading SEP on-board firmware from the Host Computer.

2.04 Wire and Cabling:

A. All interior cable shall be plenum rated.
<table>
<thead>
<tr>
<th></th>
<th>4C #22 AWG</th>
<th>4C #18 AWG</th>
<th>4C #22Sh AWG</th>
<th>6C #20Sh AWG</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.</td>
<td>West Penn Wire #25241; or approved equivalent</td>
<td>West Penn Wire #25244; or approved equivalent</td>
<td>West Penn Wire #253241; or approved equivalent</td>
<td>West Penn Wire #253270B; or approved equivalent</td>
</tr>
<tr>
<td></td>
<td>Wire Size: 22 AWG (7x30), Stranded</td>
<td>Wire Size: 18 AWG, stranded</td>
<td>Wire Size: 22AWG (7x30), Stranded</td>
<td>Wire Size: 22 AWG (7x30), stranded</td>
</tr>
<tr>
<td></td>
<td>Insulation: 0.007 inch Halar® 150 degree Celsius insulation</td>
<td>Insulation: 0.007 inch Halar® 150 degree Celsius insulation</td>
<td>Insulation: 0.007 inch Halar® 150 degree Celsius insulation</td>
<td>Insulation: 0.010 inch Halar® 150 degree Celsius insulation</td>
</tr>
<tr>
<td></td>
<td>Jacket: 0.020 inch Flexible 75 degree plenum</td>
<td>Jacket: 0.020 inch Flexible 75 degree plenum</td>
<td>Jacket: 0.020 inch Flexible 75 degree plenum</td>
<td>Jacket: 0.015 inch Flexible 75 degree plenum</td>
</tr>
<tr>
<td></td>
<td>O.D.: 0.149 inch</td>
<td>O.D.: 0.186 inch</td>
<td>O.D.: 0.153 inch</td>
<td>O.D.: 0.153 inch</td>
</tr>
</tbody>
</table>
7. O.D.: 0.182 inch

F. 2C#18AWG
1. West Penn Wire #25224; or approved equivalent
2. Wire Size: 18 AWG, stranded
3. Insulation: 0.007 inch Halar® 150 degree Celsius insulation
4. Jacket: 0.020 inch Flexible 75 degree plenum
5. Working Voltage: 300 Volts
6. O.D.: 0.141 inch

G. 1C#14AWG
1. Belden Model #8916; or equivalent
2. Wire Size: 14 AWG, Stranded
3. Insulation: 0.025 inch Polypropylene

PART 3 – EXECUTION

3.01 Examination
A. Prior to installation of the Security System specified in this document, the Contractor shall carefully inspect the site, and field-verify all dimensions of the installed work of other trades, insuring that all such work is complete to the point where this installation may properly commence.

3.02 Installation Procedures:
A. Preparation:
1. Order all required parts and equipment upon notification of award of the work or as per approved schedule.
2. Bench-test all equipment prior to delivery to the job site, per manufacturers’ installation instructions.

B. Installation:
1. General
   a. Perform all work as indicated in the Drawings and Specifications
   b. Carefully follow the instructions in the manufacturers’ Installation Manuals to insure all steps have been taken to provide a reliable, trouble-free, easy to operate system.

2. Wiring
   a. Wiring shall be run under floors using J-hooks and cable trays
      (1) Erico Caddy designed with under-floor pedestal clamp, riveted to the hook,
sized appropriately for the bundle size.

(2) 2) The following are part numbers associated with various sizes of these hooks:

a) 3/4” diameter bundles (part no. CAT12CD1B)

b) b) 1-5116” diameter bundles (part no. CAT21CD1B)

c) c) 2” diameter bundles (part no. CAT32CD1B)

(3) Wiring should follow Manhattan geometry (utilize 90 degree angles)

a) 45 degree angles or hap-hazard angles will not be accepted

b. Provide and interconnect all wire/cable from peripheral equipment to the Security System panels

c. All cable shall be hidden as much as possible

d. Transposing or changing color coding of wires is prohibited

e. Wire or cable shall not obstruct equipment controls or indicators within the enclosures

f. Communications cable shall be kept away from power circuits

g. Wire connected to ELH shall be kept away from other data cables due to the possibility of interfering with data as a result of the potential current/voltage spikes on the ELH wire

h. UL- and Code-compliant fireproofing techniques shall be provided for all penetrations of fire-rated partitions and slabs made by or used for installation of the Security System (i.e., around door contacts, and J-Boxes installed in fire-rated frames and walls)(use 3M brand Fire Chalking)

i. Wire and cable shall be protected from kinks

j. At no time shall any coaxial cable be subjected to a bend of less than a 6 inch radius

k. Wire and cable shall be inspected for faulty insulation prior to installation

l. After conduits, conductors, and enclosures have been installed, but prior to any equipment being interconnected, all wiring and cabling shall be checked and tested to insure there are no foreign grounds, opens, or shorts on any conductors or shields

3. Splicing

a. Wiring splices shall be avoided to the extent possible.

b. b. All wire-ta-wire and wire to EOL resistor shall be soldered and taped.

c. Use of splice caps, or crimp-on splice devices shall not be acceptable.

4. Enclosures, J-Boxes, and Cabinets

a. Security System/Fire Alarm/CCTV/Access electronics and all boxes in the area of the SEP shall be housed within metal enclosures with keyed alike to ES201, locking doors (located in secure spaces and contain TS’s to indicate when the key-operated doors are opened)
b. Separate UL-listed enclosure(s) for isolation relays, fuses for the electronically-controlled locking hardware, and miscellaneous devices shall be provided and sized appropriately for the number of devices to be housed (if used)

c. J- and pull-boxes shall be sized as required

d. J-Boxes shall be secured with tamper-resistant screws or locks on an enclosure with a lockable door

e. If the J-Box is located less than 10 feet above the finished floor, an additional pair of wire and aTS shall be required

f. The tamper shall be connected to the nearest available input point

g. Processors, power supplies, and other related equipment shall be mounted at the SEP location on a fire-rated plywood backboard

h. Manufacturer-recommended mounting hardware shall be used for securing ceiling mounted devices

i. Seismic bracing on appropriate equipment shall be installed

j. Security fasteners shall be provided on all J-Box, pull-box, and low-voltage electrical gutter cover-plates

k. J-Boxes shall be clearly marked for easy identification

l. The front of the Security System panels shall be labeled with the name of the installing Contractor, company address, service phone number, and the date that warranty expires

m. A copy of panel wiring and associated as built drawings shall be located in a pouch attached to the inside door of an ACP

n. All tampered enclosures shall contain separate tamper switches, 1 to ACP and 1 to CSC.

5. Panel Wiring and Termination

a. Connectors shall be installed as required by the equipment manufacturer

b. Conductors shall be carefully formed and neatly harnessed with tie-wraps spaced 1 inch – 2 inch apart so that each drops off directly opposite its terminal

c. Conductors shall be run parallel to the insides of the enclosure

d. Small wire duct (if space permits) may be used in lieu of tie-wrapping the conductors as long as there are no exposed multiple conductors greater than 4 inch in length

e. Wire and cable shall be routed away from heat producing components such as resistors, regulators, etc.

f. Conductors shall be labeled, within 4 inch from each end, with permanent marking labels and shall be easily readable

g. a termination shall be made so that there is no bare conductor at the terminal

h. Conductor insulation shall bear against the terminal or connector shoulder

i. Spade lugs shall be used on the end of conductors attaching to screw-type terminals as much as practical with the wire securely fastened
j. Enclosure barrier-strips or connector terminals shall be numbered and coded. Controls, function switches, etc., shall be clearly labeled on all equipment panels.

6. Grounding
   a. Appropriate grounding shall be provided as called out in the Specifications and Drawings or specified by the manufacturer.
   b. Earth ground shall be connected to ground rod or approved cold water pipe.
   c. Electrical or telephone ground connections shall not be used as earth grounds.
   d. Connections to mounting posts or building structural steel shall not be used as earth grounds.

7. Doors and Door Hardware
   a. Connection shall be made to ELH lock at electric power transfer, door hardware provider to make connection between lock and frame (within the door).
   b. Nothing shall be done to modify a fire-rated door or frame that would void the fire rating, otherwise the door may need to be re-certified.

8. Power To Security Equipment and Power Supplies
   a. All equipment from 120VAC circuits dedicated for security use shall be powered except as noted. All panel circuit breakers shall be marked Security Equipment - Do Not Operate.
   b. Any panic hardware that requires a separate 120VAC power booster shall have that power booster located within 150 feet of the door hardware; Distance is dependent on wire gage.
      (1) 2C #14 AWG stranded for exit devices up to 75 feet from PS873BB.
      (2) 2C #12 AWG stranded for exit devices up to 150 feet from PS873BB.
   c. Plug-in transformers shall be located at the security control panels in a lockable, tampered, ventilated electrical enclosure.
   d. A single duplex power receptacle with power hard-wired to the receptacle shall be provided within the enclosure (a power-strip may be used within the electrical enclosure).
   e. Transformers shall be clearly labeled to identify purpose and use of each.

9. Protection Of Finish
   a. Adequate means shall be taken to protect all finished parts, materials, and equipment against damage from any cause during the progress of the work and until acceptance by The University.
   b. Damaged material or equipment shall be replaced or refinished at no expense to The University.

10. System Setup
    a. Provide all initial system programming and setup including, but not limited to the following:
(1) System network programming
(2) Levels of access to the facility for system users
(3) Central station communicator programming
(4) System input and output points (priorities, test, descriptors, alarm messages, and camera and map call up with identification)
(5) All CR functions and needs
(6) All security system functions and needs

3.03 System Programming Assistance:
   
   A. Programming:
      1. The Contractor shall initially assist the University in configuring the installed devices into the existing security system in accordance with the design shown on the drawings and amendments unless otherwise directed by The University.
      2. Develop and install all building maps with icons and macros.

3.04 System Training:
   
   A. The Contractor shall provide qualified personnel to train key University-selected personnel in the operation of the installed Security System. The training program shall be designed to provide a comprehensive understanding and basic level of competence with the system. It shall be sufficiently detailed to allow the University's personnel to operate the system independent of any outside assistance.
   
   B. A comprehensive lesson plan covering all Security System component operations, configurations, and maintenance shall be submitted to the University as part of the submittal process.
   
   C. Training time shall be not less than a total of twenty (20) hours, and shall consist of:
      1. Twenty (20) hours during normal day shift periods for system operators and supervisors. Specific schedules shall be established at the convenience of the University.
   
   D. The specific training schedule shall be coordinated with the University and shall follow the lesson plan previously submitted and approved by the University. The schedule shall allow for the following:
      1. Each training session to be limited to a maximum of four (4) hours per day, unless longer sessions have been agreed upon by the University.
      2. At least one (1) refresher training session shall be provided after the system has been operational for three (3) months.
   
   E. The Contractor shall provide a cost-per-session quote (as part of the bid) for additional training sessions that the University may purchase for the first and second year of system operation.
   
   F. All training shall be completed onsite using the University's equipment unless off-site training is agreed to be more advantageous to the University. If off-site training is agreed upon, the cost for such training shall not be any greater than if the training was conducted on-site. If training is off-site, it shall be done on a complete and operational system that is parallel and equal to the system being installed for this project.
   
   G. The Contractor shall maintain time sheets verifying the total hours of training provided. (The University reserves the right to use any excess training hours not used by the time of system completion for future training, as
H. The Contractor shall provide three (3) sets of Operator/Programmer Manuals.

3.05 Acceptance Testing and Commissioning Procedure:

A. General:

1. It shall be the responsibility of the Contractor to demonstrate to the University that the security system is complete and functional as per these specifications.

2. The acceptance testing and commissioning procedure shall be a complete (as is feasibly possible) inspection/test of all security system components and functions.

3. Upon the completion of the test and having met all project requirements the Contractor may obtain project sign-off from the University on a Contractor-provided form.

B. Prior to system test and commissioning:

1. The Contractor shall complete and all specification requirements to include, but not be limited to:
   a. system installation as specified including all change bulletins
   b. initial programming
   c. initial tests
   d. As-Built Drawings
   e. System documentation

2. Copies of the Project Record Drawings and copies of the system documentation shall be submitted one (1) week prior to the scheduled acceptance test to University Security Services.

3. It shall be the responsibility of the Contractor to request the scheduling of the acceptance testing through the established project channels.

C. Test Procedure:

1. To successfully demonstrate the system operation, the Contractor shall consider the following prior to the start of the test:
   a. schedule the test at a time when all of the doors can be secured
   b. insure someone is available to monitor and verify receipt, at the SOC, of system activities, i.e., card reads, alarm reporting, etc.
   c. insure a method of communication between the SOC and inspection team
   d. set up system as follows:
      (1) secure all doors
      (2) activate all alarms
      (3) set door-held times to 10 seconds (these will need to be reset back to University-desired time after the test)
2. Acceptance testing shall be performed in not more than one (1) work day.

3. Any failure by the Contractor or Contractor-installed equipment, which causes the test to be resumed or rescheduled after all involved in the testing have been assembled on site, the additional costs incurred by the University for services rendered by others involved in the testing, i.e., University’s Consultants, required to complete the testing shall be borne by the Contractor.

   a. When all deficiencies have been remedied, Contractor shall assemble all involved during the initial test. Any additional costs for this assembly of above personnel attendance shall be borne by the Contractor.

4. As a minimum, the Contractor shall demonstrate the following in the order listed:

   a. Field Device Operation

      (1) inspection of all security panels verifying quality workmanship, cleanliness, labeling, keying, etc.

      (2) Check TSs

      (3) testing all CR-controlled doors verifying the following operations

         a) quality of workmanship

         b) invalid card - does not open door and event logged at Host Computer

         c) valid card - opens door for brief period and event logged at Host Computer

         d) door held open alarm - after holding the door open for an University agreed upon time the Server shall receive an alarm message indicating "door held open"

         e) door forced alarm - upon opening the door without the use of a card the Host Computer shall receive an alarm message indicating "door forced"

         f) P-REX functionality - shunts the door contacts allowing exiting through the door with shunting time duration set by the Host Computer software

      (4) verify with head-end receipt of all produced signals

   b. Intrusion Detection Subsystem

      (1) inspection of all devices for workmanship, etc.

      (2) checking all intrusion detection devices

      (3) verify with SCC receipt of all produced alarm signals

D. Any deficiencies identified during the inspection shall be noted and listed; however, the progress of the inspection shall not be halted to correct the deficiencies.

E. At the conclusion of the Acceptance Test there shall be are view of any system discrepancies.

F. If all work is found to be acceptable and in compliance with the project drawings specifications and bulletins, the Contractor may present a project completion and acceptance form to the University for the University's signature.
after which the warranty period begins.

G. My discrepancies or failures of tested items occur requiring the rescheduling of the test at a later date, the Contactor shall be charged for the reassembly of all persons involved in the acceptance test procedure.

3.06 Cleanup:

A. The Contractor shall remove any surplus and waste materials from the site resulting from his/her operation upon completion of work each day and shall leave involved work areas in neat, clean, and acceptable condition.

B. The Contractors shall clean all parts of the material and equipment they install. Exposed surfaces shall be free of cement, plaster, and other materials, and all oil and grease spots shall be removed with a non-flammable cleaning solvent.

C. During the progress of the work, the Contractors shall carefully clean up and leave the premises free from debris.

END OF SECTION
SECTION 13730
CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 – GENERAL

1.01 Summary

A. Section includes: A closed circuit television system, complete including the following:
   1. Cameras
   2. Power Supplies
   3. Digital Video Recorder
   4. Remote Viewing Software
   5. all related wire, cable, fittings, adapters, key-operated enclosures, and necessary System configuration and programming
   6. Training of personnel

B. Related Sections and drawings:
   2. Division 16 - Electrical
   3. Section 16800 - Security Electrical
   4. Architectural Drawings
   5. Security Drawings

C. Drawings and Specifications:
   1. Statements made in the Technical Specifications and not reflected on the Security Drawings, or conditions shown on the Drawings and not stated in the Specifications shall, in effect, be considered to be shown or stated in both. In the case of conflicting information between Drawings and Specifications, the Contractor shall notify the Owner in writing of all conflicts and request clarification prior to the purchase or installation of any equipment. The Owner shall provide clarification in writing.
   2. The Security Drawings are accurate as to available information as of the release date; however, due to the possibility of changing site or architectural conditions, the Contractor shall identify those exceptions and changes that may affect the bid response. If no exceptions or changes are presented, the Contractor shall become responsible for any changes to the work required as a consequence of such pre-existing conditions.
   3. The Drawings and Specifications are for the assistance and guidance of the Contractor; exact locations, distances, elevations, etc., shall be governed by actual field conditions.
   4. For purposes of precise building dimensions, the Architectural Drawings take precedence over the Security Drawings.
1.02 System Design Requirements:

A. Consists of a standard “off-the-shelf CCTV equipment to monitor areas as shown on the security drawings.

B. System Overview

1. Provide video monitoring of library lobby an rear entrance.

2. Camera output to ‘provide real-time (30 frames 160 fields per second) video.

3. Provide clean video pictures with no ground loop or power differential problems (no hum bars in the video display).

4. Feed the video from the cameras into a NVR with:
   a. Minimum of four (4) camera inputs
   b. Built-in video multiplexing
   c. Multiple-display options
   d. Remote control capability
   e. An alarm mode (to increase the number of pictures captured with video quality for camera called to alarm)
   f. Provide pre-alarm pictures
   g. Enhanced search features based on time/date and alarms
   h. Provide a method of detecting artificially altered pictures
   i. LAN connection
   j. Software for viewing on multiple remote computers

5. Record video based on motion sensing

6. Allow for video monitoring and playback at multiple locations via LAN connection.

PART 2 – PRODUCTS

2.01 General

A. Furnish and install (at locations shown on the Security drawings) the specified equipment to provide a completely operational Security System. However, the following subsystem items to be provided for installation shall not be considered all-inclusive.

B. All products shall be new and of manufacturer’s current and standard production.

C. Drawings and Specifications indicate major system components and may not show every component, connector, module, or accessory that may be required to support the operation specified. The Contractor shall provide all components needed for a complete and satisfactory operation.
2.02 Product Availability:

A. Prior to submitting a proposal, product availability and delivery time shall be determined and such considerations shall be calculated in the proposed Contract Time.

B. Certain specified products may only be available through factory-authorized dealers and distributors. The ability to procure the products specified shall be verified prior to submitting a proposal.

2.03 Cameras:

A. Camera. Fixed bullet housing for exterior use (V1A):

1. Speco Technologies model CVe-550EX, Pelco, or Weldex, Bullet CCTV camera; or approved equivalent.

2. Video cameras shall be color, mounted in a bullet housing, utilizing solid-state CCD image sensors, shall operate on 24VAC, and shall be governed by the following specifications:

   a. Environmental Considerations:

      (1) Operational application - indoor/outdoor, twenty-four (24) hours, continuous operation

      (2) Temperature range - minus 14 degrees F to plus 122 degrees F.

   b. Performance:

      (1) Lenses – Varifocal 5mm to 50mm

      (2) Image sensor -1/3 inch Color DSpi

      (3) Resolution - Four-Hundred-eighty (480) horizontal lines resolution

      (4) Minimum illumination -- 0.03 lux with included lens

      (5) Back light Compensation – selectable

      (6) Video output - 1.0 VPop. 75 ohms

      (7) Connectors - BNC

      (8) PS -- 24VAC, 200ma, external with ground isolation

   c. Power Consumption -- 1.3 Watts (250ma).

   d. Reliability:

      (1) Solid-state, LSI circuitry

   e. Additional features:

      (1) Enclosed in a bullet style housing

      (2) Color - steel grey
B. Camera, Fixed mini dome (V1 B):

1. Pelco, Panasonic, Sony CCTV camera in mini-dome; or approved equivalent

2. Video cameras shall be color, mounted in a mini dome, utilizing solid-state CCD image-sensors, shall operate on 24VAC, and shall be governed by the following specifications:

   a. Environmental Considerations:

      (1) Operational application - indoor/outdoor, twenty-four (24) hours, continuous operation.

      (2) Temperature range - plus 4 degrees F to plus 158 degrees F

   b. Performance:

      (1) Lenses – Varifocal 2.8 to 6mm

      (2) Image sensor -1/3 inch Color DSP

      (3) Resolution - Four-Hundred-eighty (480) horizontal lines resolution

      (4) Minimum illumination - 0.3 lux with f1.2 lens

      (5) Back light Compensation - selectable

      (6) Video output - 1.0 Vpop, 75 ohms

      (7) Connectors - BNC

      (8) PS - 24VAC, 200ma, external with ground isolation

   c. Power Consumption - 1.3 Watts (250ma).

   d. Reliability:

      (1) Solid-state, LSI circuitry

   e. Additional features:

      (1) Enclosed in high-resistant, Lexan mini dome

      (2) Dome interior color – white

      (3) 120 degree Pan, 180 degree Tilt, 75 degree Rotation (when installed)

2.04 Camera Power Supply:

A. Multi-Camera Power Supply:

1. A1tronix, ESD. Pelco

2. 24VAC PS with eight (8) individually power isolated, one-amp outputs in a rack mountable metal enclosure. Each output shall be fused at 1Amp.
2.05 Head-End Equipment

A. Digital Video Recorder:

1. Dedicated Micros D4DX4G-160GB. Border Collie Solutions Inc, (BCSI) model BCP-800, or Kalatel Digital Video Recorder, or approved equivalent
2. Built-in 16Q-GB HOD capacity
3. Video compression
4. Image update rates for Live and Record modes of up to 120 unique pictures per second
5. Pre- and post-alarm recording, selectable per camera
6. Record speed selectable per camera
7. Record mode selectable per camera (time-lapse, event or both)
8. Record image quality (high, medium or standard) selectable per camera
9. Intrusion and activity motion detection
10. View live or recorded images remotely on a separate PC using included software.
11. Simultaneous live, recording and playback
12. Continue recording while you review, retrieve, or archive image on peripheral storage devices
13. Simultaneous live and playback images on a single monitor
14. Video motion detection (intrusion and activity) with motion search
15. Search by alarm, time, date, camera number, and ASCII cash register or ATM text
16. Graphical display for improved recorded data analysis
17. Archive onto OAT, AIT or recordable CD's
18. Save images as JPEG or BMP for easy distribution or email.
19. Secret watermark confirms that recorded or shared images have not been altered
20. Contain a built-in macro for easy switching between standard and daylight savings time
21. Support LAN/WAN Ethernet access
22. Support Ethernet bandwidths or 10Mb or 100Mb
23. Remote setup over 10/100 BaseT Ethernet
24. Ability to save remote setup for back up or to copy other sites
2.06 Wire and Cabling:
   A. All interior cable shall be plenum rated.

PART 3 – EXECUTION

3.01 Examination
   A. Prior to installation of the Security System specified in this document, the Contractor shall carefully inspect the site, and field-verify all dimensions of the installed work of other trades, insuring that all such work is complete to the point where this installation may properly commence.

3.02 Installation Procedures:
   A. Preparation:
      1. Order all required parts and equipment upon notification of award of the work.
      2. Bench-test all equipment prior to delivery to the job site, per manufacturers’ installation instructions.
   B. Installation:
      1. General
         a. Perform all work as indicated in the Drawings and Specification
         b. Carefully follow the instructions in the manufacturers’ Installation Manuals to insure all steps have been taken to provide a reliable, trouble-free, easy to operate system.
      2. Wiring
         a. Wiring shall be run under floors using J-hooks and cable trays.
            (1) Erico Caddy - designed with under-floor pedestal clamp, riveted to the hook, sized appropriately for the bundle size.
            (2) The following are part numbers associated with various sizes of these hooks:
               a) 3/4” diameter bundles (part no. CAT12CD1B)
               b) 1-5/16” diameter bundles (part no. CAT21CD1B)
               c) 2” diameter bundles (part no. CAT32CD1B)
            (3) Wiring should follow Manhattan geometry (utilize 90 degree angles)
               a) 45 degree angles or hap-hazard angles will not be accepted.
               b) Provide and interconnect all wire/cable from peripheral equipment to Security System SEPs.
               c) All cable shall be hidden as much as possible
               d) Communications cable shall be kept away from power circuits
e. UL- and Code-compliant fireproofing techniques shall be provided for all penetrations of fire-rated partitions and slabs made by or used for installation of the Security System (i.e., around door contacts, and J-Boxes installed in fire-rated frames and walls)(use 3M brand Fire Chalking)

f. Wire and cable shall be protected from kinks

g. At no time shall any coaxial cable be subjected to a bend of less than a 6inch radius

h. Wire and cable shall be inspected for faulty insulation prior to installation

i. After conduits, conductors, and enclosures have been installed, but prior to any equipment being interconnected, all wiring and cabling shall be checked and tested to insure there are no foreign grounds, opens, or shorts on any conductors or shields.

3. Splicing

a. Splice coax cable using BNC barrel connectors, but should not be required

b. The following methods for splicing coax cable are unacceptable:

   (1) use of F-Connectors
   (2) use of solderless crimp connectors designed for splicing wire
   (3) twist-on wire splice connect
   (4) soldering the center connector and shield, wrapping with tape

4. Enclosures, J-Boxes, and Cabinets

a. Security System/Fire Alarm/CCTV/Access electronics and all boxes in the area of the SEP shall be housed within metal enclosures with keyed alike to ES201, locking doors (located in secure spaces and contain TSs to indicate when the key-operated doors are opened)

b. J- and pull-boxes shall be sized as required

c. Power supplies. shall be mounted at the SEP location on a fire-rated plywood backboard

d. Manufacturer-recommended mounting hardware shall be used for securing ceiling mounted devices

e. Seismic bracing on appropriate equipment shall be installed

f. Security fasteners shall be provided on all J-Box, pull-box, and low-voltage electrical gutter cover-plates

g. J-Boxes shall be clearly marked for easy identification

h. The front of the Security System panels shall be labeled with the name of the installing Contractor, company address, service phone number, and the date that warranty expires

i. A copy of panel wiring and associated as built drawings shall be located in a pouch attached to the inside door of an ACP

j. Camera enclosures to be tampered independently to card access and security systems.
5. **Grounding**
   a. Appropriate grounding shall be provided as called out in the Specifications and Drawings or specified by the manufacturer.
   b. Earth ground shall be connected to ground rod or approved cold water pipe.
   c. Electrical or telephone ground connections shall not be used as earth grounds.
   d. Connections to mounting posts or building structural steel shall not be used as earth grounds.

6. **Power To Security Equipment and Power Supplies**
   a. All equipment from 120VAC circuits dedicated for security use shall be powered except as noted. All panel circuit breakers shall be marked Security Equipment - Do Not Operate inch or equivalent.
   b. Plug-in transformers shall be located at the security-control panels in a lockable, tampered, ventilated electrical enclosure.
   c. A single duplex power receptacle with power hard-wired to the receptacle shall be provided within the enclosure (a power-strip may be used within the electrical enclosure).
   d. Transformers shall be clearly labeled to identify purpose and use.

7. **Protection Of Finish**
   a. Adequate means shall be taken to protect all finished parts, materials, and equipment against damage from any cause during the progress of the work and until acceptance by The Owner.
   b. Damaged material or equipment shall be replaced or refinished at no expense to The Owner.

8. **CCTV Requirements**
   a. Check all cameras as required for:
      2. Vertical phasing.
      3. Clean signal at monitors (no 60Hz signal riding on video signal or other interference with video signal).

9. **System setup**
   a. Provide all initial system programming and setup including, but not limited to the following:
      1. System network programming.
      2. Levels of access to the facility for system users.
      3. Integration programming.
      4. System input and output points (priorities, descriptors, alarm messages, and camera and map call up with identification).
3.03 System Training:

A. The Contractor shall provide qualified personnel to train key Owner-selected employees in the operation and maintenance of the installed Security System. The training program shall be designed to provide a comprehensive understanding and basic level of competence with the system. It shall be sufficiently detailed to allow the Owner's personnel to operate the system independent of any outside assistance.

B. A comprehensive lesson plan covering all Security System component operations, configurations, and maintenance shall be submitted to the Owner as part of the submittal process.

C. Training time shall be sufficient to meet the above training objectives.

D. Training shall be conducted during normal shift periods for system operators and supervisors. Specific schedules shall be established at the convenience of the Owner.

E. Additional system training shall be provided to the Owner's supervisory personnel for performing supervisory functions.

F. The specific training schedule shall be coordinated with the Owner and shall follow the lesson plan previously submitted and approved by the Owner. The schedule shall allow for the following:

G. Each training session to be limited to a maximum of four (4) hours per day, unless longer sessions have been agreed upon by the Owner.

H. At least one (1) refresher training session to be provided after the system has been operational for three (3) months.

I. The Contractor shall provide a cost-per-session quote (as part of the bid) for additional training sessions that the Owner can purchase for the first and second year of system operation.

J. All training shall be completed onsite using the Owner's equipment unless off-site training is agreed to be more advantageous to the Owner. If off-site training is agreed upon, the cost for such training shall not be any greater than if the training was conducted on-site. If training is off-site, it shall be done on a complete and operational system that is parallel and equal to the system being installed for this project.

K. The Contractor shall maintain time sheets verifying the total hours of training provided. (the Owner reserves the right to use any excess training hours not used by the time of system completion for future training, as specified.)

L. The Contractor shall provide three (3) sets of Operator/Programmer Manuals, with complete descriptions of all keyboard programming functions (including sample programs), and twelve (12) sets of unused programming forms (as shown in the manual and as used on this project).

3.04 Acceptance and Commissioning Test Procedure:

A. As a minimum, the Contractor shall demonstrate the following in the order listed:

1. Head-end functions
   a. CCTV Monitoring and Control Equipment
      (1) Production of clear, crisp, properly focused video images of all cameras on all
CCTV monitors

(2) Verification of the full range of PTZ for all moveable cameras

(3) Verification of proper sequencing of all CCTV cameras

(4) Proper operation and playback of video recordings

2. Field Device Operation
   a. Inspection of camera installation for workmanship, cleanliness, etc.

3.05 Cleanup:

A. The Contractor shall remove any surplus and waste materials from the site resulting from his/her operation upon completion of work each day and shall leave involved work areas in neat, clean, and acceptable condition.

B. The Contractors shall clean all parts of the material and equipment they install. Exposed surfaces shall be free of cement, plaster, and other materials, and all oil and grease spots shall be removed with a nonflammable cleaning solvent.

C. During the progress of the work, the Contractors shall carefully clean up and leave the premises free from debris.

END OF SECTION
SECTION 15010
MECHANICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 Description
A. Comply with the requirements of DIVISION 1. The requirements of this SECTION apply to all work of DIVISION 15.

B. Provide a complete working installation with all equipment called for in proper operating condition. Documents do not undertake to show or list every item to be provided. When an item not shown or listed is clearly necessary for proper operation of equipment, which is shown or listed, provide an item which will allow the system to function properly at no increase in the Contract Amount.

1.02 Quality Assurance
A. Related Work Specified Elsewhere:
   1. All electrical wiring (except that specifically indicated on Control Drawings). DIVISION 16.
   2. Motor starters, Division 16 (except prewired packaged systems, in which case they must conform to DIVISION 16).

B. Examination of the Site:
   1. Visit the site prior to bidding. Take measurements and such other information as to locations, depths, capacities and sizes of existing piping and ductwork to which connections may be made or which may be abandoned or which require rerouting. If any of the above requires extra work due to discrepancies or omissions on the drawings if such omissions or discrepancies have been revealed by examination before bidding, the Contractor should report the discrepancy to the University Representative a minimum of three days prior to receipt of bids. If additional work is required due to omissions and discrepancies after the contract for the work is signed and if such omissions or discrepancies would have been revealed by a visit to the site before receipt of bids, then the corrective additional work shall be performed at no additional cost to the Owner.

C. Requirements of Regulatory Agencies:
   1. Standards Compliance: When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), American Gas Association (AGA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted to the University Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization, which is competent to perform acceptable testing and is approved by the University Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.

   2. Any specific reference in these Specifications to codes, rules, regulations, standards, manufacturer's instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at date of submission of Bid, unless the Document is shown dated.

   3. Perform the work in conformance with the applicable requirements of all regulatory agencies, including,
but not limited to the following:


b. California Code of Regulations (CCR).
   (1) Title 8, Division 1, Chapter 3.2 - California Occupational Safety and Health Regulations (CAL/OSHA).
   (2) Title 8, Division 1, Chapter 4 - Safety Orders.
   (3) Title 24, Building Standards.
   (4) Part 2 - California Building Code
   (5) Part 3 - California Electric Code
   (6) Part 4 - California Mechanical Code
   (7) Part 5 - California Plumbing Code


4. Nothing in the Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules, regulations.

5. When Drawings or Specifications exceed requirements of applicable laws, ordinances, rules, regulations, Drawings and Specifications take precedence.

6. It is not the intent of Drawings or Specifications to repeat requirements of codes except where necessary for completeness or clarity.

7. Work herein shall comply with all applicable requirements of CCR Title 8, Division 1, as they apply to this project, both in reference to Contractor's operations in performing his work and also in construction result to be accomplished. Where an omission or a conflict appears between OSHA requirements and the Drawings and Specifications, OSHA requirements shall take precedence.

D. Licenses, Permits and Fees

1. Provide, procure and pay for all permits, licenses, fees, etc., required to carry on and complete the Mechanical Work. Contact all applicable utility authorities and include in bid all fees, charged by any such authorities.

E. Operating and Maintenance Instruction:

1. Furnish the services of competent instructors who will give full instruction to the designated personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the equipment or system specified. Each instructor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours) of instruction furnished shall be one (1).

1.03 Submittals

A. General

1. Submit shop drawings, catalog data, supplemental data, for all materials, equipment in all Sections of this DIVISION in accordance with the requirements of SECTION 01340, "SHOP DRAWINGS,
PRODUCT DATA AND SAMPLES," and as specified hereinafter.

2. Forward all submittals to University Representative, together, at one time. Individual or incomplete submittals are not acceptable. Refer to Section 01340 for number of copies required.

3. Submittals shall have been reviewed and stamped by the General Contractor in accordance with the requirements of the GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION. Submittals not so stamped will be returned without review.

4. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment. Words "as specified" are not sufficient identification.

5. Identify each submittal item by reference to Specification SECTION Paragraph in which item is specified, or drawing and detail number.

6. Organize submittals in same sequence as they appear in specification sections, articles, or paragraphs.

B. Indexing:

1. Submittals shall be indexed according to specification DIVISION and SECTION number and paragraph to identify each item. Sporadic submittals, incomplete data, or unidentified data, or data not showing features to coordinate item with other work will not be accepted.

C. Binders: Prepare submittal material in accordance with the requirements of Division 1:

D. Submittal literature, Drawings and wiring diagrams shall be specifically applicable to this project and shall not contain extraneous material. The literature shall be clearly marked to indicate the proposed item and any accessories or options to be furnished. Submittals shall include, but not be limited to the following:

- Pipe Trim
- Fixtures
- Fixture Trim
- Insulation
- Air Handling Equipment,
- * Drives and Guards
- Valves w/Service and Location
- Hangers and Seismic
- Bracing ++
- Sound Attenuators
- Air Inlets and Outlets +
- Filters
- Vibration Isolators
- Temperature Controls
- Fire Protection Equipment
- Vents
- Duct Trim

Notes:

* Include a family of rating curves. See applicable specification section.

+ With a detailed list including Room Nos., neck sizes, throws and NC levels.

++ See Section 15200.
E. Resubmittals shall respond to comments made on the original submittal and shall be marked with a resubmittal number and dated. Resubmittals not in conformance with these requirements will be returned without review.

F. Shop Drawings: (See also Section 01340)

1. Submit shop drawings for piping, ductwork, and equipment. Do not begin fabrication until shop drawings have been coordinated with all trades and have been reviewed and accepted by the University Representative.

2. Drawings size shall match the Contract Drawings in size and title block, with a minimum scale of 1/8 inch per foot, except as specified otherwise. Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment; and equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Ductwork and piping layouts and Mechanical Room layouts shall be drawn at a minimum scale of 1/4 inch per foot. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

3. The University Representative's review of Shop Drawings is not intended to verify dimensions or quantities, nor to coordinate items shown on these Drawings. He will review them for general conformance with design concept of the project and general compliance with the information given in the contract requirements of the plans and Specifications. Contractor is responsible for dimensions, which shall be confirmed and correlated at the job site, for fabrication processes and techniques of construction, for coordination of his work with that of all other trades and the satisfactory performance of his work.

G. Record Drawings

1. Installation drawings shall be drawn at the site by the Contractor on reproducible paper and shall be fully coordinated for interferences by all trades. The Contractor shall maintain at the jobsite a complete set of prints of the installation drawings for all mechanical work. These prints shall be kept up to date by recording all changes daily. The progress of the work shall be clearly, neatly and accurately designated, coloring in the various pipes, ducts and equipments as they are erected. This process shall incorporate all changes to the original drawings including formal change orders or other instructions issued by the University Representative. Principal dimensions of all concealed work shall be recorded including inverts of buried piping and height to underside of ducts.

2. These marked up prints will be used as a guide for determining the progress of the work installed. They will be inspected monthly by the University Representative and shall be corrected immediately if found either inaccurate or incomplete.

3. Prior to final acceptance of the Work of this Division, submit properly certified Record Drawings to the University Representative for review and make changes, corrections, or additions as the University Representative may require. After the University Representative's review and any required Contractor revisions, deliver the Record Drawings to the Owner on electronic media in AutoCAD format. The University Representative and Engineer do not assume any responsibility for the accuracy or completeness of the Record Drawings.

H. Operating & Maintenance Manuals:

1. Furnish an operation and maintenance manual for each item of equipment as per requirements of Division 1. Furnish one complete manual prior to the time that equipment tests are performed, and furnish the remaining manuals before the contract is completed. Inscribe the following identification on the cover: the words OPERATION AND MAINTENANCE MANUAL, the name and location of the equipment or the building, the name of the Contractor, and the contract number. The manual shall include the names, addresses, and telephone numbers of each subcontractor installing equipment, and of the local representatives for each item of equipment. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings.
folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; a control sequence describing start-up, operation and shutdown; description of the function of each principal item of equipment; the procedure for starting; the procedure for operating; shutdown instructions; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; performance data; parts list and a copy of the warranty. The parts lists for equipment shall indicate the sources of supply, recommended spare parts, and the service organization which is reasonably convenient to the project site. The manual shall be complete in all respects for equipment, controls, accessories, and associated appurtenances provided.

2. Manuals shall conform to SECTION 01730, OPERATION AND MAINTENANCE MANUALS.

I. Letters from manufacturers certifying their supervision of equipment installation and start-up procedures.

J. Three (3) copies of certification signed by Owner's representative, attesting to their receipt of instructions required by 1.02.E.

1.04 Product Delivery and Storage

A. Identify materials and equipment delivered to site to permit check against approved materials list, reviewed shop Drawings.

B. Protect from loss or damage. Replace lost or damaged material and equipment with new at no increase in the Contract Amount.

1.05 Drawings and Coordination With Other Work

A. Contract Drawings:

1. For purposes of clarity, legibility, the Contract Drawings are essentially diagrammatic to extent that many offsets, bends, unions, special fittings are not shown. Exact locations of items are not indicated, unless specifically dimensioned.

2. Exact routing of piping, ductwork, etc., shall be governed by structural conditions, obstructions. Contractor shall make use of data in Contract Documents. University Representative reserves right, at no increase in price, to make any reasonable change in location of mechanical items, exposed at ceiling and/or on walls, to group them into orderly relationships and/or increase their utility. Verify University Representative's requirements in this regard prior to roughing-in.

3. In addition to the Shop Drawings called for under SUBMITTALS the Contractor shall prepare large scale layout drawings showing location of equipment, piping and duct runs, and all other elements of mechanical systems provided under this DIVISION. Include sections of congested areas to show relative position and spacing of affected elements.

4. Refer to the electrical "E" series drawings and specifications, Division 16 for the service voltage, power feed, control and interlock wiring for equipment specified under this section. The Contractor has full responsibility for the following items of work:

   a. Review the electrical "E" series drawings and Division 16 to verify that the electrical services (power, control, interlock, etc.) provided are adequate and compatible with the equipment requirements.

   b. If additional electrical services are required over and above what is indicated on the electrical "E" series drawings and in Division 16, such as more control interlock conductors, larger feeder, or separate 120V control power source, the Contractor shall include in his bid the cost to furnish and install the additional electrical services.

   c. Prior to proceeding with the installation of any additional electrical work, the Contractor shall
submit detailed drawings indicating the exact scope of additional electrical work to the University Representative for review and approval.

5. Provide templates, information, and instructions to other DIVISIONS to properly locate holes and openings to be cut or provided for electrical Work.

6. Not all offsets in ductwork or piping are shown. Decide which item to offset or relocate. Maintain required slope in piping.

B. Coordination:

1. Work out all "tight" conditions involving Work under this DIVISION and Work in other DIVISIONS in advance of installation.

PART 2 – PRODUCTS

2.01 Materials

A. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two year use shall include applications of equipment and materials under similar circumstances and of similar size.

B. Alternative Service Record: Products having less than a two-year field service record may be acceptable on approval of the University Representative if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

C. Service Support: Major equipment items shall be supported by service organizations. The Contractor shall submit a certified list of qualified permanent service organizations for support of the equipment, which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

D. Identify materials, equipment by manufacturer's name, nameplate data. Remove unidentified materials, equipment from site.

E. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified.

F. Where no specific make of material or equipment is mentioned, any first class product of reputable manufacturer may be used, provided it conforms to requirements of system and meets acceptance.

G. Equipment Guarding

1. Rotating Equipment Safety:

   a. Couplings, Motor Shafts, Gears and other exposed rotating or rapidly moving parts shall be fully guarded in accordance with OSHA requirements. The guards shall be cast iron or expanded metal. Guard parts shall be rigid and suitably secured and shall be readily removable without disassembling the guarded unit.

   b. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded in accordance with Title 8, Division 1, Chapter 4, Sub-chapter 7, Group 6. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe
operation and maintenance of equipment.

H. Equipment or material damaged during transportation, installation or operation is considered as totally damaged. Replace with new. Variance with this permitted only with written acceptance.

I. Provide an authorized representative to constantly supervise work of this DIVISION, check all materials prior to installation for conformance with Drawings and Specifications.

J. Equipment shall be as described in the respective SECTIONS of DIVISION 15 and as shown.

2.02 Substitutions

A. See SECTION 01640, "SUBSTITUTIONS" and the following.

B. Where more than one specific name is used, it is to be understood that the name mentioned first represents the manufacturer whose equipment has been used as the basis of design. All other names mentioned are to be considered substitutions within the meaning of this paragraph, and no additional cost to the Owner shall accrue due to any revisions, additions or deletions required to make substituted equipment perform in accordance with the plans and specifications.

C. Any redesign necessitated by substitutions shall be provided by the Contractor and shall be subject to review and approval by the University Representative.

D. Substitutions will not be considered if they are indicated or implied on Shop Drawings or Project Data Submittal without the formal request required by SECTION 01640.

PART 3 – EXECUTION

3.01 Demolition

A. Remove all piping, ducts, fixtures, equipment, etc., where shown or otherwise indicated to be removed. Cap piping at mains or source.

3.02 Installation

A. Manufacturer's Recommendations

1. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

2. Where dimensions or specific installation and operating instructions of equipment are not provided in the Drawings or Specifications, the Contractor shall perform the Work according to approved manufacturer's specifications and recommendations. Any material and work required under this heading shall be supplied at no additional cost to the Owner.

3. Equipment which is required to be field assembled shall be assembled under the direct supervision of the manufacturer's agent. Prior to the final acceptance submit letters from the manufacturers that this has been done.

B. Equipment: Accurately set and level with supports neatly placed and properly fastened. Properly fasten equipment in place with bolts to prevent movement in earthquake. No allowance of any kind will be made for failure on part of Contractor to foresee means of bringing in or installing equipment into position inside building.
C. Piping and/or Ductwork Systems:

1. Worked into complete, integrated arrangement with like elements to make work neat appearing, finished.

2. Run concealed, except as shown or noted otherwise; where exposed, run parallel with walls or structural elements; vertical runs plumb; horizontal runs parallel with structure and level or uniformly pitched as appropriate.

3. Install with adequate passageways free from obstructions, as high as practicable to maintain adequate head room, as shown or as required. Notify University Representative before installation whenever head room of less than 7-feet 6-inches will result. Coordinate with work of other DIVISIONS to achieve proper head room as specified in this DIVISION.

4. Provide bases, piers, metal frames and backings, hangers and supports for the fixtures and systems furnished under the Mechanical Work.

5. Expansion and Contraction: Make adequate provisions, whether those provisions are shown on Drawings or not.

6. Cleaning and Closing: Inspect all piping, ductwork, and equipment before placing; clean interior before closing. Close all piping and ductwork at end of each day's work.

D. Sleeves, Chases, and Concrete Inserts:

1. Cutting and Patching: In accordance with SECTION 01070, "CUTTING AND PATCHING".

2. Provide, to cause no delay, all required sleeves, chases, inserts, anchor bolts, etc., and be responsible for correct location, installation of same.

3. Locating and sizing of openings for ductwork through walls, etc., under this DIVISION. Framing of openings provided by respective DIVISIONS in whose work opening is made.

4. Penetrations of fire or smoke rated walls, partitions, and floors:
   a. Pack space between piping or duct and sleeve or opening with materials approved by Underwriters Laboratories for use in through-penetration fire stop systems. Materials, methods, and installation shall be in accordance with UL approved listings and shall be designed to act as a firestop as well as a cold smoke, noxious gas, and water sealant. Submit UL listings for all such systems to be used.

5. Pipe Sleeves: Where not otherwise indicated or specified, sleeves through outside walls, floors or roof slabs shall be zinc-coated steel pipe conforming to ASTM A120. Sleeves through inside partitions shall be zinc-coated sheet steel not less than 0.0217-inches thick conforming to ASTM A525.

E. Cutting and Repairing:

1. Do all cutting, repairing, including structural reinforcing, necessary for Work under this DIVISION.

2. Do no cutting or patching without University Representative's review. Repair damage done by this cutting equal to original condition in University Representative's opinion.

3. Assume responsibility for all damage to any part of premises or Work of other DIVISIONS, caused by leaks or breaks in piping or equipment furnished and/or installed under this DIVISION during construction and guarantee period.

3.03 Testing and Adjusting

A. Furnish all labor and test equipment required under this DIVISION and in accordance with SECTION 15990 and as
B. Clean and purge equipment and piping before each test.

C. Test various Mechanical systems in portions as work progresses. Any system or portion previously tested shall become part of any repeated test when it becomes part of distribution or collection system.

D. Repair leaks by remaking with new material. Makeshift leak stopping methods are not acceptable.

E. Should any piece of equipment or material fail in any of the tests, immediately remove, replace with new; retest system.

F. Maintain test pressures for periods stated, or as directed without loss in pressure, except that due to change in temperature or atmospheric pressure during test.

G. Perform all tests in accordance with the requirements and under supervision of authorities having jurisdiction.

H. Field Balancing:

1. All fans, blowers and exhausters greater than one (1) horsepower, and all flexible coupled pumps regardless of horsepower, shall be dynamically balanced in the field by a company specializing in machine balancing. Provide a written report on completion of balancing indicating final condition of each piece of equipment. For additional requirements, see Section 15200.

I. Air and Water Prebalancing Requirements:

1. Complete and test all systems early enough to enable completion of air and water balancing prior to Owner move in.

2. Prior to any demolition or other work performed on the existing supply and exhaust air distribution systems, perform the following work on the existing fan systems:
   a. Measure and record the following parameters for the system fan:
      (1) RPM
      (2) Fan Motor Amperage
      (3) Static pressure upstream and downstream of the fan
      (4) CFM by taking a traverse at a convenient location or locations.
   b. Measure and record the air quantities to all areas and/or duct branches outside the work area that are served by fan systems which also serve the work area. This information must be complete enough to achieve the air balance as required by article 3.03 of Section 15990.
   c. Submit all quantities measured above to the University Representative. Do not proceed with demolition or construction until University Representative has approved this submittal.

3. If the measured quantities differ from the amount shown by more than plus or minus 10-percent, report the discrepancy to the University Representative. The University Representative will then issue the necessary instructions how to proceed.

4. Complete or perform the following Work prior to commencement of the balancing procedure:
   a. Testing of all systems.
   b. Prior to the start of balancing, complete all punch list items that will affect balancing of the
c. Install all dampers and other balancing devices shown and specified and check to be sure they are properly installed, indexed, and in good working order.

d. Schedule the Work of all other trades to eliminate system shutdown for any reason once balancing is started.

e. Schedule the Work of other trades to assure uninterrupted access to mechanical equipment rooms as well as conditioned spaces.

f. Provide labor and material necessary to perform any system revisions required to allow completion of balancing.

g. Align all drives.

h. Set sheaves to provide indicated capacities at specified static pressures.

i. Set all manual dampers to 100-percent open position.

j. Set all balancing cocks to 100-percent open position.

k. Remove all adjustable pitch pulleys from the motor shaft; the shaft and pulley threads shall be cleaned, lightly oiled; and the pulley remounted, aligned, and properly adjusted.

l. Drill 3/8-inch diameter holes in low velocity ductwork with burrs removed, for temperature, pressure, and velocity readings; and provide holes in drive guards that will permit tachometer readings without removing guards. Locate as specified hereinafter and as directed. Install a replaceable rubber plug in each hole.

m. Clean interior of all plenums, casings, and ducts; and install temporary and final filters before starting any systems.

n. Place all systems in automatic operation.

o. Notify the University Representative prior to start of tests to enable balancing to be scheduled.

5. Drill test holes in the following locations:

a. Each side of each filter, fan, coil, and multi-blade damper; 12-inches O.C. for traverse readings in all main ducts and as directed in the field. Provide at least ten (10) extra plugs to the Owner.

6. When all the above testing and adjusting Work has been completed, submit a written statement to the University Representative, stating that all the testing and prebalancing requirements have been met. Final Balancing shall not begin until the certificate has been approved by the University Representative.

J. At completion of Work, provide written certification that all systems are functioning properly without defects.

3.04 Cleaning and Painting

A. Refinish Work supplied with final finish under this DIVISION if damaged to satisfaction of University Representative.

B. Matte black paint finish ducts behind grilles and diffusers where duct is visible.

C. Thoroughly clean all equipment, fans, pumps, motors, piping and all other materials under this DIVISION free from all rust, scale, and all other dirt before covering or painting is done, or the systems put in operation. Leave in condition
satisfactory to the University Representative.

D. Thoroughly flush out all domestic water piping with domestic water under pressure before faucets, flush valves and other constantly operated devices are installed.

E. Space Heating Water Piping: See Section 15060.

F. Protect all finished surfaces of fixtures with heavy paper pasted thereon, or by other means, throughout the period of construction.

G. Cleaning Ductwork:
   1. Clean ductwork inside and out before grilles are installed and before fans are operated. The Contractor shall meet the performance requirements and utilize the evaluation criteria of NADCA Standard 01-1992, “Mechanical Cleaning of Non-Porous Air Conveyance System Components”.

H. The Contractor shall at all times keep the premises free from accumulation of waste material and debris caused by his employees. At the completion of the project, remove refuse from within and around the building. All tools, scaffolding and surplus materials shall also be removed, leaving the site of his Work broom clean.

I. Completely cover all plumbing fixtures and all motors and other moving machinery to keep free of dirt and water during construction. Using visqueen, or other suitable material, effectively cap all openings into ducts and pipes to keep foreign matter out during construction.

J. Lubricate all equipment at completion of Work. Furnish Owner with a written lubrication schedule for all equipment.

K. Properly prepare Work under this DIVISION to be finished painted under SECTION 09900, “PAINTING”.
   1. All exposed mechanical work which in general includes piping, ductwork, insulation, metal items, equipment and supports shall be painted except that polished aluminum, stainless steel, chrome plate and other finely finished materials shall not be painted unless otherwise noted.
   2. Unless otherwise noted all finish colors shall be selected by the University Representative.
   3. Materials previously shop prime coated by the manufacturer and which have been scuffed or otherwise damaged shall be touched up with the same materials used for priming. Prime coats shall be of a lighter tint than final coats.

3.05 Signs, Labels and Identification for piping and valves

A. Signs and Labels:
   1. Fasten a red-headed tack to each T-bar suspended ceiling pushout tile at heating coils, fire dampers, valves, control devices, etc.
   2. A printed sign shall be posted at water treating equipment stating, "USE NO CHROMATES".
   3. A printed sign shall be posted at each automatically started equipment stating, " WARNING THIS MACHINE IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME".

B. Pipe Identification:
   1. Identify and color-code all piping including piping in furred ceiling spaces. Provide directional arrows on circulating systems. Identification shall be in accordance with ANSI A13.1-1981, Scheme for Identification of Piping Systems (OSHA) and as specified herein.
   2. Plastic Markers: Seton Setmark, or equal, for concealed locations or if located in mechanical rooms; or
Seton Opticode, or equal, for exposed pipes in public areas, with wording as selected by the University Representative. Each marker must show approved color-coded background, proper color of legend in relation to background color, approved legend letter size, approved marker length.

3. Location for Pipe Identification:
   a. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
   b. At each branch and riser take-off.
   c. At each pipe passage through wall, floor and ceiling construction.
   d. On all horizontal runs spaced 25-feet maximum.

4. Install pipe identification after painting of piping.

C. Valve Identification:
   1. Provide tags on all control and line shut-off valves. Tags shall note valve service and number as hereinafter specified and shall be Seton Style 250-BL, Brady, or equal, brass tag fastened to the valve stem with copper wire.
   2. Provide three (3) typewritten schedules giving numbers, service and locations, and notations of normally open or closed, of all tagged valves, where purpose of location is not easily identifiable. Enclose each schedule in separate transparent plastic binder.

3.06 Equipment Identification

A. Properly identify each piece of equipment and its controls using engraved laminated plastic descriptive nameplates, attached to equipment and controls using round head brass machine screws, pop rivets or contact cement. Cardholders in any form not acceptable.

B. For equipment installed under a raised floor, properly identify each fan powered unit, damper, control valve and other equipment requiring maintenance or access. Such identification shall be approved by the Architect and located at the carpet tile or top of raised floor, at the ceiling or other location approved by the Architect.

END OF SECTION
SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.01 Description

A. The requirements of this SECTION apply to all Work of DIVISION 15 where applicable. The materials, equipment and methods herein are generally common to the various SECTIONS of this DIVISION of the Specification. Materials that apply to only one SECTION are generally included in that SECTION.

B. Where items specified in other SECTIONS of DIVISION 15 conflict with requirements of this SECTION, the former shall take precedence.

1.02 Quality Assurance

A. Equipment and Accessories

1. Supply all equipment and all accessories new, free from defects.

2. All items of a given type shall be the product of the same manufacturer.


B. Reference Standards: (Refer to individual Mechanical SECTIONS for additional reference standards.)

1. ANSI/ASME - B31.9 Building Services Piping

2. ANSI B2.1 - Pipe Threads


8. AWWA C209-83 - Cold applied tape coatings for exterior of connections and fittings for steel water pipe lines.

9. AWWA C214-83 - Tape Coating Systems for exterior of steel water pipe lines.


11. ASC - Adhesive and Sealant Council.


13. NEMA-MG1 National Electrical Manufacturer's Association, Motor and Generator Standards.

PART 2 – PRODUCTS
2.01 Materials

A. Access Doors in Ceilings or Walls:

1. Furnish under this DIVISION where shown, or required by Regulatory Agencies and for access to all concealed valves, shock absorbers, unions, fire dampers, etc., even though access doors are not shown for Mechanical Work. Mark each door to establish its location and deliver doors for installation under SECTION 09250.

2. Unless otherwise shown or designated, access doors for reaching valves, traps, air vents, duct access doors, and handholes and cleanouts set in walls shall be 12” x 12” for reaching small items within wrist reach of walls, or 24” x 24” for larger items, or items at greater distances than wrist reach, or at ceilings. Access doors shall be as specified in SECTION 09250. All ceiling access door locations shall be coordinated with Architectural Reflected Ceiling Plan.

3. Access doors are not required in T-bar suspended pushout ceilings or accessible tile ceilings.

4. For any access door not specifically shown on reflected ceiling plans or Architectural elevations, obtain the University Representative’s approval of the location, size and type.

5. Access doors shall be as requirements of Section 09250.

B. Piping Schedules:

1. Refer to individual Mechanical SECTIONS for general information, materials, and execution of the proper piping for each system.

C. Valve Schedules: See Valve Schedules in SECTION 15100 VALVES

D. Buried Warning and Identification Tape:

1. Polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as stated below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, “CAUTION: BURIED (intended service) LINE BELOW” or similar wording. Color and printing is to be permanent, unaffected by moisture or soil.

   a. Warning Tape Color Codes

      (1) Yellow: Gas, Oil, Dangerous Materials

      (2) Blue: Water Systems

      (3) Green: Sewer Systems

      (4) White: Steam Systems

   b. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements indicated above. Minimum thickness of the tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise with a maximum 350 percent elongation.

   c. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements indicated above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. The tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when the tape is buried up to 3 feet deep. Encase the metallic element of the tape in a protective jacket or provide with other means of
corrosion protection.

E. Dielectric Waterways or Dielectric Flanges: Victaulic Clearflow, Watts, or equal.

F. Strainers:
   1. Wye Type: Armstrong Type A1SC, Sarco or equal on steel lines with 250-lb. iron body and stainless steel .045 inch mesh strainer and Type F4SC 125-lb. bronze body on copper lines. Chas. M. Bailey, Zurn or equal.
   2. Basket Type: Cast iron or fabricated steel, with bolted bonnet cover and perforated elements. Elements - Type 304 stainless steel or Monel metal screens with .045"-233 perforations per square inch. Provided with back-up strainers as recommended by the manufacturer. Bailey, Zurn, or equal.

G. Escutcheon: Beaton, Corbin, or equal.

H. Pipe Hangers: See schedule on Drawings, and individual mechanical specification SECTIONS; see also "SECTION 15200 NOISE, VIBRATION, AND SEISMIC CONTROL."

I. Pipe Hanger Shields:
   1. Calcium silicate inserts and jacket such as Pipe Shields A1000 with painted galvanized steel jacket, Kin-Line or equal.
   2. High density blown polyurethane inserts such as Rilco CC2000.


PART 3 -- EXECUTION

3.01 Installation

A. Installation of Piping:
   1. Definition of "PIPING": The term "piping" as used in Drawings or these Specifications, means all pipe, fittings, nipples, valves, unions, etc., as may be required for a complete, functional system.
   2. The general layout of piping on the drawings indicates branch runouts terminated at individual or groups of fixtures or equipment. The piping shall be considered continuous and finally connected to all fixtures and equipment.
   3. Run all pipes in the approximate locations shown. Sizes are given on the Drawings. Unless otherwise shown, lines shall be installed in furred spaces. Offset piping wherever necessary to obtain headroom. In all cases, install pipe lines to conform to actual conditions such as offsetting to clear structural members, lights, ducts, etc. Run all piping true to line and grade. The finished work shall present a neat and workmanlike appearance. Unless otherwise noted, minimum pipe size is 1/2" for all piping systems.
   4. Accurately cut pipe and work into place without springing or forcing, except when cold springing is required.
   5. Install pipe lines free from traps, air pockets, sags and bends. Arrange water piping for draining at low points and provide vent valve at high points. Drain valves shall be accessible.
   6. Wherever changes in size of pipes occur, the changes shall be made with reducing fittings, as the use of bushings will not be permitted.
   7. Securely fasten all piping and equipment in the building to the building construction. Secure branch
piping runouts in partitions to steel partition members with tie wire. Provide pipe taping separation between steel and copper.

8. Make branch takeoffs with reducing tees or with line size tee and reducers, except that branches less than half diameter of main may be made with forged branch welding outlet fittings.

9. Piping in any partitions, through plates, studs, etc. shall have sufficient clearance from structure to allow for expansion, contraction of piping. No bare piping should touch wood, concrete, etc., any time.

10. All pipes piercing roof membranes shall be flashed water-tight. Hot pipes shall be fitted with a welded cowl with air space between cowl and flashed curb to allow for any expansion.

11. Provide all piping passing through finished floors, ceilings, partitions, or walls exposed to view with chromium-plated escutcheons in bathrooms, prime coated elsewhere. Fit escutcheons for insulated pipe over insulation.

12. Pipe penetrations at Fire and Smoke rated walls and floors: As specified under “SECTION 15010, MECHANICAL GENERAL REQUIREMENTS”.

13. Pipe penetrations of exterior foundation walls or slabs on grade are to be sealed using Thunderline Link Seal, Calpico, or equal.

14. Cut copper tubing with copper tube cutters, ream and size with sizing tools, and thoroughly clean before application of flux or solder.

15. Tees may be cut into 2-inch and larger copper tubing using Bonney, Brazolets or equal or by using Tubemaster Tee Turner, Serlachius or equal T-Drill.

16. Copper to Steel Connections:
   a. Make all copper pipe connections to ferrous piping in domestic water systems with Clearflow, Watts, or equal, dielectric waterway or isolation flanges. Dielectric unions not acceptable.
   b. All uninsulated copper pipe shall be isolated from supports by means of Stoneman Trisolators or Unistrut Unicushion. Install pipe shields at all hangers on suspended insulated piping as follows:
   c. All insulated lines use PSI Model A1000, or Superstrut 791-H.
   d. Use Model A3000 and A2000 or extra heavy bottom jacket when pipe hangers span greater than 10 feet and for all pipe roller applications.
   e. Use high density blown polyurethane inserts at seismically-braced hangers.

17. Unless otherwise indicated, drains from all equipment and piping having drain connection, where shown or required, shall be run to the nearest adequately sized clear water waste receptacle.

18. Provide ground joint unions at all regulating valves, steam traps, equipment, and where required in lines 2-inches and smaller. Use flanges in lines 3-inches and larger. 2-1/2-inch valves and equipment may have unions or flanges at the option of the Contractor.

19. Open-ended line valves shall be provided with plugs or blind flanges.

B. Flexible Connections: See SECTION 15200, “NOISE, VIBRATION AND SEISMIC CONTROL”.

C. Straight pipe field joints, fittings, flanges and other field joints shall have a manually applied tape coating system conforming to AWWA C209. Tape shall be Type I or Type II, spirally wrapped with a minimum overlap of 1/2-inch applied in a minimum of two layers to provide a minimum total film thickness of 50 mils. After wrapping, all sections shall be tested with an electrical holiday detector in accordance with C209 Section 4.4. Defects shall be repaired in
accordance with C209 Section 3.4. An affidavit of compliance that all materials and work comply with these specifications shall be submitted.

1. At all times during construction the field procedures of AWWA C209 Section 5.1 and 5.2 shall be followed.

D. Piping Joints:

1. Threaded Joints
   a. Pipe threads shall be tapered threads in accordance with ANSI/ASME B31.9 and ANSI B2.1 for IPS threaded work. No screwed pipe joints shall be caulked or screwed up with rope or packing of any kind. Teflon pipe tape may be used where appropriate. When erecting plated, polished, or soft metal piping, friction wrenches shall be used exclusively.

2. Brazed and Soldered Joints:
   a. Brazed joints and soldered joints shall be in accordance with ANSI/ASME B31.9-1982 with preparation, techniques and procedures in accordance with the Copper Tube Handbook publication of the Copper Development Association. Brazing materials shall be as specified in the various Sections of these specifications.
   b. Soldered joints in domestic water systems shall be lead free.

3. Welded Joints:
   a. Welding shall comply with the provisions of the latest revision of ASME Code for Pressure Piping ANSI/ASME B31.9-1982 Building Service Piping.
   b. Boiler External Piping: For steam boilers with pressure greater than 15 psig or water heating units operating at pressures greater than 160 psig and temperature greater than 250 degrees F., the boiler external piping shall comply with the provisions of the latest revision of Section I of the ASME Boiler and Pressure Vessel Code ANSI/ASME BPV-1. For boilers not exceeding the above pressure and temperature limits ANSI/ASME B31.9 shall apply.
   c. Unless otherwise indicated, welding shall be permitted on 1-1/2 inch and larger black steel pipe lines. Use long radius forged steel welding elbows. Tees may be cut in where the branch pipe does not exceed one size less than half the size of the main. If a larger branch is used, then only weldolets or threadolets may be installed.

3.02 Quality Assurance

A. Welding:

1. Welding Procedure Specifications: Before any welding is performed, the Contractor shall submit copies of his welding procedure specification for all metals included in the work together with proof of its qualification as outlined in ANSI B31.1

2. Performance Qualification Record: Before any welder or operator shall perform any welding, the Contractor shall submit 3 copies of the Welder's Performance Qualification Record in conformance with ANSI B31.1 showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition the Contractor shall also submit each welder's assigned number, letter, or symbol which shall be used to identify the work of the welder which shall be affixed immediately upon completion of the work. Welders making defective welds after passing a qualification test shall be given a requalification test and upon failing to pass the test shall not be permitted to work this contract.

3. Surface Conditions: Surfaces to be welded shall be free from frost, moisture, loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth, uniform, and free from fins, tears, and other defects which might affect proper welding. Slag shall be removed from flame cut edges to be
welded by grinding, but temper color need not be removed. Each layer of weld metal shall be cleaned thoroughly by wire brushing prior to inspection and deposition of additional weld metal.


5. Quality of Welds: The quality of welds shall be in accordance with ANSI B31.1. The surface of the finished welds shall have a bright metallic luster after cleaning, shall be fairly smooth with regular, even ripples, and shall be uniform in contour. Except as necessary to correct defects, the surfaces shall not be dressed, smoothed, or finished for improving their appearance unless required specifically by the project specification, its accompanying drawings, or the approved detail drawings of the work. Welds shall be sound throughout and fused thoroughly, and shall be free from gas pockets, oxides, slag inclusions, and surface porosity, except that very small pores or specs of oxides or slag will be allowed if dispersed widely and if not larger or more numerous than those produced in passing qualification tests. Welds shall be free from overlaps, undercuts and excessive convexity. The inside of the pipe shall be free from globules of weld metal which would restrict the pipe area or might become loose.

6. Correction of Defects: Defective or unsound welds shall be corrected by removing and replacing the welds with new welds, or as follows:

   a. Excessive convexity: Chip or grind weld to required size.

   b. Undercutting, shrinkage cracks, craters, blowholes, and excessive porosity: Chip or grind weld to sound weld and base metal and deposit additional weld metal.

   c. Undersize and excessive concavity: Clean weld and deposit additional weld metal.

   d. Overlapping and lack of fusion: Remove weld by chipping or grinding and reweld.

   e. Slag inclusions: Chip or grind weld to remove slag and fill with weld metal.

   f. Removal of adjacent base metal during welding: Chip or grind weld to sound base and weld metal and form full size by depositing additional weld metal. Pipe or fittings which cannot be rewelded satisfactorily shall be replaced with new pipe or fittings at the Contractor's expense. Caulking of welds shall not be done. Before adding weld metal or rewelding, the surfaces shall be cleaned thoroughly. The removal of weld metal from a defective weld shall not extend into the base metal beyond the weld penetration. Where incomplete fusion is disclosed by chipping or grinding to correct defects, that part of the weld shall be removed and rewelded. In chipping or grinding welds, the weld or base metal shall not be nicked or undercut.

B. Brazing and Soldering:

   1. Brazing and soldering procedure qualification shall conform to ANSI B31.1. Brazing procedure for joints shall be as outlined in the Copper Tube Handbook published by the Copper Development Association.

   2. Soldering, soldering preparation and procedures for joints shall be in accordance with ANSI B31.1 and as outlined in the Copper Tube Handbook published by the Copper Development Association.

C. Inspection, Examination and Testing of Pipe Joints shall be in accordance with Chapter VI of ANSI/ASME B31.9-1982 and SECTION 15990, "TESTING".
SECTION 15060

PIPE AND PIPE FITTINGS

PART 1 – GENERAL

1.01 Description of Work

A. Work included in this Section: Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Heating hot water system piping.
2. Fire protection system.

1.02 Related Work specified Else Where

A. Requirements of General Conditions, Division No. 1 and Section 15010: Mechanical General Requirements, apply to all work in this section.

B. Related work in following sections:

1. Section 15090: Supports and Anchors
2. Section 15100: Valves
3. Section 15200: Noise, Vibration and Seismic Control
4. Section 15300: Automatic Fire Protection

1.03 Requirements of Regulatory Agencies

A. California Code of Regulations (CCR):

1. See Section 15010

1.04 Applicable Publications: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American National Standards Institute (ANSI) Publications:

2. B16.9 Factory Made Wrought Steel Butt Welding Fittings
3. B16.11 Forged Steel Fittings, Socket Welding and Threaded
4. B16.12 Cast Iron Threaded Drainage Fitting
5. B16.18 Cast Bronze Solder Joint Pressure Fittings
6. B16.21 Nonmetallic Gaskets for Pipe Flanges
7. B16.22 Wrought Copper and Bronze Solder-Joint Pressure Fittings
8. B16.39 Malleable Iron Screwed Fittings
9. B18.2.1 Square and Hex bolts and Screws, including Hex Cap Screws and Lag Screws
10. B18.2.2 Square and Hex Nuts
11. B31.1 Power Piping
12. B31.9 Building Service Piping
13. B40.1 Gages, Pressure, Indicating Dial Type, Elastic Element

B. American Society for Testing and Materials (ASTM) Publications:
1. A 47 Malleable Iron Castings
2. A 53 Pipe, Steel, Black and Seamless Steel Pipe
3. A 74-82 Cast-Iron Soil Pipe and Fittings
4. A 120 Pipe, Steel, Black Welded and Seamless for Ordinary Uses
5. A 183 Carbon Steel Track Bolts and Nuts
6. A 307 Carbon Steel External and Internally Threaded Standard Fasteners
7. A 386 Zinc Coating on Assembled Steel Products
8. A 536 Ductile Iron Castings
9. B 32 Solder Metal
10. B 88 Seamless Copper Water Tube
11. C 564 Rubber Gaskets for Cast-Iron Soil Pipe and Fittings

C. American Society of Mechanical Engineers (ASME) Publications:
1. ASME Boiler and Pressure Vessel Code and Interpretations
2. Section VIII - Pressure Vessels - Division 1

D. American Welding Society Inc. (AWS) Publication:
1. A5.8-76 Brazing Filler Material

E. Copper Development Association Inc. Publication:
1. Copper Tube Handbook

F. Underwriters Laboratories Inc. (UL).

G. Cast Iron Soil Pipe Institute Publications 301-78 and 310-78.


1.05 Quality Assurance

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

B. Supply all equipment and accessories new and free from defects.

C. Supply all equipment and accessories in compliance with the applicable standards listed in article 1.04 of this section and with all applicable national, state and local codes.

D. All items of given type shall be the products of the same manufacturer.

E. Welding materials and labor to conform to ASME code and applicable state Labor Regulations.

F. Use fully qualified welders licensed by state authorities.

G. Each length of pipe, fitting, trap, fixture or device used in any piping system shall be stamped or indelibly marked with:
   1. Weight or quality.
   2. Maker’s name or mark.

1.06 Submittals

A. Manufacturer’s Literature and Data

1. Piping and Fittings, Gaskets, Brazing and Soldering Metals, Piping Accessories, Shop Drawings and Catalog Cuts: Submit shop drawings and catalog information showing plan, elevations, dimensions, capacities.

2. PART 2 – PRODUCTS

2.01 Classes and Maximum Working Pressures

A. Equipment and piping components shall be suitable for use under the maximum working pressures indicated. Except as modified herein, the pressure temperature limitations shall be as specified in the referenced standards and specifications.

2.02 Pipe Services

A. Relief, Safety Valve discharge, welded or screwed Steel, Schedule 40, ASTM A53 Grade B

B. Heating hot Water System

   1. Heating water: Steel schedule 40 roll grooved, welded to ASTM A53 Grade B. For 2 1/2 and smaller may use Type L Copper.

C. Fire Protection

   1. Inside: Schedule 40 steel to ASTM A53 or A135, grooved end, screwed or welded.

2.03 Pipe and Pipe Fittings

A. Pressure Piping
1. Pressure piping shall be:
   a. Ferrous and copper piping conform to requirements of ANSI Safety Code for Pressure Piping, B31.1.
   b. Be commercially round and straight.
   c. Be of uniform quality and workmanship.
   d. Be free from all defects.
   e. Be identified.

2. Pressure ratings herein are "W.O.G." or "Water Working Pressure."

   a. 2" and smaller.
   b. Cast-iron banded fittings, ANSI B16.4, 125 psi class.
   c. Malleable iron, ANSI B16.3, 150 psi class.

   a. 2-1/2" and larger.
   c. Steel welding-neck flanges and flanged fittings, ANSI B16.5, 150 psi.

5. Black Steel, grooved end, ASTM A-53 1-1/4" and larger, grooved end fittings as hereinafter specified.
   a. Roll grooved - Schedule 40
   b. Schedule 10 pipe shall not be used.

6. Copper Tubing:
   a. ANSI H23.1.
   b. Hard temper for all other piping.
   c. Wrought-copper, solder joint fittings, ANSI B16.22, in sizes available.
   d. Cast-bronze solder-joint fittings, ANSI B16-18, only in sizes not available in wrought copper.
   e. Cast bronze, threaded, ground-joint unions, ANSI B16.18, 2" and smaller.
   f. Cast-bronce, flanged unions, ANSI B16.24, 150 psi class, 2-1/2" and larger.

7. Brass:
   a. Standard weight and red brass pipe, 85 percent copper, 15 percent zinc, ANSI H27.1.
   b. 125 psi threaded brass fittings, ANSI B16.15

C. Flange Gaskets:
   1. Full faced or flat ring type to suit flange facings, selected from one of following materials:
      a. Steel Piping Systems:
         (1) Full face fluorinated elastomer.
         (2) 1/16" thick.
      b. Domestic Hot and Cold Water:
         (1) Red rubber, ASTM D1330.
         (2) 1/16" thick.
         (3) Similar to Crane Style 555. Garlock 3000.
   2. Gaskets coated with thread lubricant when being installed.

D. Flange Bolts, Nuts and Washers:
   1. Steel piping, carbon steel conforming to ASTM A307, grade B, and material for nuts shall conform to
      ASTM A194, grade 2. Dimensions of bolts, studs, and nuts shall conform to ANSI B18.2.1 and ANSI
      B18.3.2 with threads conforming to ANSI B1.1 coarse type with class 2A fit for bolts and studs, and
      class 2B fit for nuts.
   2. Copper piping systems, bronze bolts.

E. Unions:
   1. Steel piping 2-1/2" and smaller:
      a. 250 psi: ground joint
      b. Similar to Grinnell Fig. J-3, Watts 3004.
   2. Steel piping larger than 2-1/2": welding flanges.
   3. Copper Piping:
      a. Similar to Nibco No. 733.
   4. Other systems to match piping.

F. Dielectric Unions, flanges, waterways, couplings.
   1. 2-1/2" and smaller:
      a. 250 psi WOG conforming to ASTM F-492-77
      b. Threaded ends, electro-zinc plated steel body with thermoplastic liner.
      c. Similar to Victaulic “Clearflow”.
2.  3” and larger:
   a.  Flanged, 175 psi WOG. ANSI B16.42 (iron) and B16.24 (bronze).
   b.  Similar to Watts 3110. EPCO Model X.

2.04  Escutcheons, Flashing and Sleeves

A.  Escutcheons:
   1.  Similar to Grinnell Fig. 2 for copper tubing.
   2.  Similar to Grinnell Fig. 13 for steel pipe.
   3.  Brushed chrome plated brass.

B.  Flashings for pipes through roofs:
   1.  See Architectural drawings.
   2.  Secure pipe below roof to prevent relative movement.

C.  Sleeves; of following types as required:
   1.  Minimum 22 gauge, galvanized steel sleeves if removed entirely after concrete pour, Schedule 40 PVC if remaining after pour.
   2.  With welded PVC flange to serve as water stop in waterproofed walls.

2.05  Shock Absorbers

A.  For Copper Piping:
   1.  Brass body, with diaphragm or piston, pre-charged similar to Watts Series 15, “or approved equal”.
   2.  In domestic water system, bearing National Sanitation Foundation Seal.

2.06  Expansion Joints

A.  304 or 321 stainless steel bellows type with stainless steel flow liner, carbon steel flanges, minimum 3" axial compression. Similar to Hyspan series 2500.

PART 3 – EXECUTION

3.01  Installation

A.  Arrangement:
   1.  Except for large scale details, piping is diagrammatically indicated.
      a.  Install generally as shown.
   2.  Do not scale Drawings for exact location of piping.
   3.  Install piping to coordinate with other trades and accommodate field conditions.
   4.  Piping arrangement unless otherwise noted:
a. Arrange piping neatly along walls.
b. In neat, horizontal groups.
c. Each group to be in one plane, in so far as possible.
d. Piping connections to equipment shall be arranged so that removal of equipment or components of equipment including tube withdrawal from chillers, pump casing, shaft seals and similar work can be accomplished with the least amount of disassembly or removal of the piping system. Piping connected to equipment with vibration isolators shall be provided with flexible connections, which shall conform to vibration and sound isolation requirements of Section 15200.

5. Do not sleeve structural members without consent of University Representative.

6. Maintain minimum 1” clearance from adjacent work, including insulation, except as noted or approved.

7. Install piping concealed above ceilings or in walls unless otherwise indicated.

8. All steel pipe and fittings, not insulated or wrapped to be cleaned.

B. Expansion, Contraction and Bending:

1. Install piping with provisions for expansion and contraction.
   a. Provide expansion loops, offsets, swing joints, and/or expansion joints where indicated or otherwise required. Nesting of grooved joint couplings for expansion provision not permitted.

2. Do not spring or force piping during installation.

3. Do not bend piping without use of pipe bending machine.

C. Sloping, Air Venting and Draining:

1. Pitch space heating water piping for drainage where possible, or run level. Provide 3/4” drain valves at all low points on main hot lines. Install 2” diameter by 6” long air chambers on main hot lines at all high points where required, with 1/4” copper tubing, Type L, hard copper, drain run from the top of the chamber to an accessible location and terminated with a manually operated needle valve. Install plugged needle valve vents at equipment high points.

2. Connect heating water branch piping to bottom of mains. (Except as detailed).

3. Provide drain valves and hose adaptors at all low points in piping on water systems; provide drain valves and hose adaptors at system low point and at equipment connections.

D. Strainers:

1. Provide strainers in hot water lines to protect orifices, automatic valves, and pumps from foreign materials. Strainer shall be located close to equipment it is intended to protect. Strainers shall have isolating service valves to permit servicing the strainer with minimum loss of fluid. Provide clearance for removal and replacing of strainer screens.

E. Valves:

1. Install at equipment to allow maintenance or isolation, and to establish proper and sequential operation of the complete system. Shell and tube heat exchangers shall have valves installed so that tubes are accessible for cleaning or replacing. Plate and frame heat exchangers shall have valves installed so as to not impede removal of plates.
F. Piping Specialties:
   1. Locate and orient thermometers and gauges to permit observation by personnel standing on floor.
   2. Provide instrument cocks at pressure gauges.
   3. Provide straight runs of piping upstream and downstream from flow meters as recommended by manufacturer.

G. Grooved Couplings:
   1. Where grooved couplings occur at a frequency greater than 4 joints in 10 feet use rigid style.
   2. See section 15090 for support requirements.

H. Copper:
   1. Crimping of copper tubing prohibited.
   2. Isolate copper pipe and tubing from contact with steel.
   3. For branch drops and rises to plumbing fixtures, anchor branch to wall with drop-ear ell or tee.
   4. On exposed piping wipe clean all solder joints.

I. Care of Floors:
   1. Do not set pipe vises or threading machines on any unprotected concrete floors.
   2. Cover floor when making plumbing connections to avoid staining floors with oil, white or red lead or other substances.
   3. Contractor shall bear cost of removing any stains.

3.02 System Installation

A. Fire Protection:
   1. See Section 15300, Automatic Fire Protection System.

B. Threaded Joints for steel, copper pipes.
   1. Sealed with sealant compounds or teflon tape.
   2. Sealant compounds:
      a. General Service: John Crane JC-40, Permatex “Blue”, “or equal”.
      b. Fuel gas, refrigerant: John Crane No. 2 Plastic Lead Seal “or equal”.

C. Welded Joints:
   1. In addition to requirements of Section 15050, welding of pressure piping shall be done by welders who have been qualified by recognized agency within 6 months prior to date of Contract.
      a. Perform welding in accordance with provisions of latest issue of all applicable codes including:
(1) ASME Boiler Construction Code
(2) ANSI Code for Pressure Piping

b. Standard Procedure Specifications of, and operators qualified by National Certified Pipe Welding Bureau will be considered as compliance with requirements of Specifications.

2. Where required, peen and wheel-grind welds.

3. Ends of pipe may be burned for welding:
   a. Grind bevel and remove scale between welding joint.
   b. Ragged edges with metal beads, poor alignment other inferior work will be rejected.

4. Perform welding with oxyacetylene or electric arc process.

5. Welded Branches:
   a. Welded branch connections not permitted with schedule 10 pipe.
   b. Where welded branches have intersecting center lines provide stress calculations per ASME B31.1.

D. Soldered and Brazed Joints:

1. Use 95-5, tin-antimony for domestic water, solder for other copper piping.

2. Brazing filler material BCuP-3 or BCuP-4 to AWS A5.8 during brazing of the pipe connections, the interior of the pipe shall be purged continuously with dry nitrogen. Use a flow meter and regulator to control flow rates.

3. Clean surfaces to be jointed, of oil, grease, rust and oxides.
   a. Remove grease form fittings by washing in solution of 1/16 sodium carbonate and three gallons hot water.
   b. Clean socket of fitting and end of pipe thoroughly with emery cloth to remove rust and oxides.

3.03 Adjustment and Cleaning

A. General:

1. During construction:
   a. Keep openings in piping closed to prevent entrance of foreign matter.
   b. Clean pipe, fittings and valves internally.
   c. Hammer welds to remove slag and weld beads.

B. Water systems:

1. Upon start-up fill with clean water.

2. Install temporary filter bags in line strainers during start-up.
3. Add alkaline detergent.
   a. Sodium silicate and/or sodium phosphate with nonfoaming wetting agent.
   b. Phenolphthalein alkalinity to 2000 to 5000 ppm as CaCO3.

4. Circulate water of each system at respective design flow rates.
   a. Three (3) hours.
   b. At end of period remove and clean strainers and blow off low points.
   c. Completely drain out entire systems of cleaning solution.
   d. Refill systems with clean water and circulate for additional 3-hour period at end of which interval, completely drain systems.
   e. Refill with clear water.

3.04 Field Quality Control

A. General Tests:
   1. Less than 100 psi operating pressure & vacuum lines.
      a. Test hydrostatically to 150 psi.
   2. Over 100 psi operating pressure:
      a. Test hydrostatically to 1-1/2 times operating pressure.
      b. Never exceed test pressure ANSI B16.1 basis.
   3. Duration: 2 hours.
      a. With system valves capped and pressure apparatus disconnected.
         (1) Pressure change: none
         (2) Compensate for temperature change.
   4. Leaks and defects:
      a. Repair or replace as directed.
      b. Without additional cost.
   5. Test concealed piping prior to concealment.
   6. Refer to other section for tests to plumbing systems and other special piping systems.
   7. Notify University Representative and Owners inspector in writing one week before test.
   8. Furnish written report and certification that tests have been satisfactorily completed.
9. It is the Contractor's responsibility to plan for the testing procedure and to provide all necessary plugs, flanges and fittings, or to temporarily cap pipes to perform the tests.

END OF SECTION
SECTION 15090
SUPPORT AND ANCHORS

PART 1 – GENERAL

1.01 Description of Work
A. Work included in this Section: Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:
   1. Pipe Hangers and Supports
   2. Duct Hangers and Supports
   3. Equipment Anchors

1.02 Related Work and Requirements
A. Requirements of General Conditions, Division 1 and Section 15010 General Mechanical Requirements apply to all work in this Section.
B. Related work in following sections:
   1. Section 15060: Pipe and Pipe Fittings
   2. Section 15200: Noise, Vibration and Seismic Control
   3. Section 15880: Ductwork

1.03 Quality Assurance
A. Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:
   4. California Code of Regulations, Title 24, Building Standards.
B. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
C. All items of a given type shall be the products of the same manufacturer.

1.04 Submittals
A. Submit the following:
   1. Shop Drawings showing attachments to structure, and product data in accordance with Section 15010 – Mechanical General Requirements.
   2. Calculations showing deflections of trapeze hangers or other multiple pipe supports.
   3. Include structural calculations when required by Section 15200 Noise, Vibration and Seismic Control.

PART 2 – PRODUCTS

2.01 Manufactures
A. Hangers and Supports: Steel
   1. B-Line
   2. Superstrut
   3. Unistrut
   4. Tolco
   5. or equal

B. Expansion Shields:
   1. ITT Phillips Drill Co.: Red Head
   2. Hilti Fastening Systems
   3. or equal

C. Miscellaneous Attachment Accessories:
   1. B-Line
   2. Superstrut
   3. Tolco
   4. or equal

2.02 Pipe Hangers and Supports

A. Where pipe supports are not shown but are required to avoid excessive pipe deflections, provide in accordance with schedule and to meet seismic code requirements. Pipe supports shall be similar in construction to those detailed on the Drawings for similar applications.

B. Spacing:
   1. Piping not otherwise indicated:
      a. Maximum spacing for horizontal piping:

      | Type of Pipe | Size                | Maximum Spacing | Hanger Size |
      |--------------|---------------------|-----------------|-------------|
      | Steel        | 1-1/2 in and smaller| 7 ft            | 3/8         |
      |              | 2 in. to 4 inches   | 10 ft           | 2           |
      |              | 5 inches and larger | 12 ft           | 5/8         |
      | Brass or copper | 3/4 in. and smaller | 5 ft            | 3/8         |
      |              | 1 - 1-1/4 in.      | 6 ft            | 3/8         |
      |              | 1-1/2 - 3 in.     | 8 ft            | 2           |
      |              | 4 in. and larger   | 10 ft           | 5/8         |

C. Supports
   1. Provide additional supports at:
      a. Changes in direction.
      b. Branch piping and runouts over 5 ft.
      c. Concentrated loads due to valves, strainers and other similar items.
      d. At valves 4 in. and larger in horizontal piping.
      e. Support piping on each side of valve.
f. Where number of grooved couplings exceeds 3 between supports or provide continuous steel between supports.

g. Vertical supports are not required within 2.5 feet of wall penetrations for pipes 8 inches in diameter and smaller.

2. Other piping support spacing shall be as scheduled on Drawing or as required by referenced standard.

D. Pipe Bracing shall be provided as required in Section 15200 Noise, Vibration and Seismic Control.

E. Fastening: Non-metallic Pipes shall be anchored for limiting expansion where shown or required by means of non-metallic clamps or other approved means, fastened to the pipe by approved means and rigidly attached to the building construction.

F. Multiple pipes shall be attached to zinc coated steel channels using zinc coated clips or pipe clamps with zinc coated steel nuts and bolts, channel nut springs to be 18-8 stainless steel. For external supports use hot dipped galvanized or baked epoxy coated steel channels and angles.

G. Single pipe hanger to be zinc coated steel Clevis type with spacer bar and nuts and rod.

H. Struts, mounting brackets, channels, structural box sections, etc. shall be galvanized steel with zinc rich touch up of cut edges.

I. Floor stands shall only be used where indicated on the Drawings.

1. Pipe sections and fittings may be used for supports where lightly loaded. Floor stands shall be anchored to the floor with no less than 4 bolts.

2. Floor stands may be used only for vertical loads. Pipe diameter shall be a minimum of 1/12 of vertical height of stand.

J. Riser clamps at each floor:

1. Non metallic pipes shall be supported with solvent welded collar above loose pipe clamp.

2. Galvanized steel riser clamp for steel pipes. Similar B line B3373C.

3. Plastic coated steel riser clamp for copper pipe. Similar B line B3373CTC.

2.03 Structural Anchors

A. Expansion Bolts

1. Hilti Kwik Bolt TZ, ITW Red Head “Trubolt”, or equal conforming to Appendix D ACI 318, as modified by CBC-2007.

2. Do not exceed manufacturer’s published allowable working loads.

B. Bear Clips: B-Line Fig. B3060 side angle clips, Superstrut, or equal.

1. B-line B2505 Stainless Steel for roof slab and external.

2. B-line B2505 Superstrut 452 Galvanized for internal use only.

C. Bear Clamps: B-Line Fig. B3055, Superstrut, or equal.

D. Maximum load safety factors:

1. Static loads: 5

2. Vibratory loads: 8

3. Shock loads: 10

2.04 Pipe Shields
A. PVC pipe, uninsulated, see Section 15050 Basic Mechanical Materials and Methods.

B. Copper pipe bearing on metal surface, including hangers, use minimum 1/16 inches PVC separation strip, or approved cushion strip. Minimum length 12 inches. Where pipe bears on wood or PVC, no shield is required.

C. For all insulated pipes see Section 15050 Basic Mechanical Materials and Methods.

2.05 Supplementary Supports

A. Where support spacing is more frequent than distance between structural members provide steel angles, channels or beams sized to provide a deflection less than 1/240 of span when fully loaded, to transfer pipe support loads to structural members.

B. Where deflection of center of trapeze support exceed 1/240 of distance between hanger rods provide additional hanger rods.

2.06 Duct Hangers and Supports

A. See Section 15880 Ductwork and Accessories

PART 3 – EXECUTION

3.01 Pipe Hangers, and Supports and Guides

A. General:
   1. Assure adequate support for pipe and contents.
   2. Prevent vibration or swaying.
   3. Provide for expansion and contraction.
   4. Supports of wire, rope, wood, chain, strap perforated bar or any other makeshift device not permitted.
   5. Comply with applicable requirements at ANSI B31.1.0 and B31.2 for piping.
   6. Support piping independently so that equipment is not stressed by piping weight or expansion.
   7. See Section 15200 Noise, Vibration and Seismic Control for hangers, guides, anchors and supports requiring vibration isolation units.
   8. Hangers and supports shall have minimum safety factor of 5, based on ultimate tensile or compressive strength, as applicable, of material used.

B. Horizontal piping, except as noted:
   1. Adjustable clevis type and rod:
      a. All services at or below 250 degrees F.
   2. Rollers or slide bases:
      a. At pipe stands.
   3. Trapeze hangers:
      a. Provide individual guides for pipes on trapezes.
      b. Where rods are unequally loaded, design for maximum load at both ends.
      c. Deflection of channel not to exceed 1/240th of span.
   4. Threaded rods:
      a. 2 in vertical adjustment with 2 nuts each end for positioning and locking.
b. Size as indicated hereinbefore.

c. For double rod hangers: 1 size smaller than scheduled.

5. Adjust trapeze and individual hanger rods so as to equalize loads on successive hangers.

C. Vertical piping:
   1. Base support:
      a. Riser clamp as specified.
      b. Hanger within 24 inches of elbow.
   2. Guides at every floor
   3. Top support:
      a. Hanger within 24 inches.
      b. Provisions for expansion.
   4. Intermediate supports: pipe clamp at floor:
      a. See 2.2J.
      b. Extension ends bearing on concrete.

D. Install Cushion strip pipe isolators between steel hangers and:
   1. Uninsulated copper tubing.
   2. Wherever any pipe requires sound and vibration isolation.

3.02 Attachment to Structure

A. Concrete and CMU
   1. Install attachments with expansion shields. Shot in anchors may not be used.

B. Side Wall Supports:
   1. Stud Walls:
      a. Toggle bolts.
      b. Lag screws into wood backing.

C. Roof Decks;
   1. Through-bolts for roof mounted ducts, pipe and equipment. Provide weatherproofing of penetration where exposed to outdoors.
   2. Beam clamps or beam clips for suspended ducts, pipe and equipment.

END OF SECTION
SECTION 15100

VALVES

PART 1 – GENERAL

1.01 Description

A. The requirements of this SECTION apply to all Work of DIVISION 15 where applicable. The valves, materials, and methods herein are generally common to the various mechanical systems described in other SECTIONS of DIVISION 15. Automatic valves, control valves, backflow preventers and other specialty valves are specified on the drawings or in other SECTIONS of DIVISION 15.

B. Provide valves as specified herein for:

1. Heating Hot Water

C. Related Work Specified Elsewhere:

1. Valves, materials and methods that apply to SECTION 15300, "FIRE PROTECTION/AUTOMATIC SPRINKLER SYSTEM", SECTION 17900, "CONTROLS" are included in those sections. Valve Identification Tags and Labels: See SECTION 15010, "GENERAL MECHANICAL REQUIREMENTS".

D. Where valves specified in other SECTIONS of DIVISION 15 conflict with requirements of this SECTION, the former shall take precedence.

1.02 Quality Assurance

A. Valves and Accessories

1. Supply all valves and all accessories new, free from defects.

2. All items of a given type shall be the product of the same manufacturer.

B. Product Delivery and Storage: Store valves in a protected area. Keep valves in closed position to protect valve seats.

C. Reference Standards: (Refer to individual Mechanical SECTIONS for additional standards)

1. American Society for Testing and Materials (ASTM) Publications:

   a. A 47-77 Malleable-Iron Castings
   c. A 216 Grade WCB Cast Carbon Steel
   d. A 217 Grade CA15 Cast 11-1/2 -13 Chromium Stainless Steel
   e. B 61 Cast Steam Bronze Castings
   f. B 62 Composition Bronze or Ounce Metal Castings
   g. B 584 Copper Alloy Bronze Castings

2. American Water Works Association (AWWA) Publications:
PART 2 – PRODUCTS

2.01 Heating Hot Water

A. Shut-off or sectional valves 2 inch and smaller shall be:

1. Ball Valves, 600 psi CWP, with cast brass bodies, replaceable reinforced teflon seats, conventional port, blowout proof seams, chrome plated brass ball, and threaded ends.
   a. Stockham S-216-BR-RT
   b. Crane 9302
   c. Nibco T-580-BR-R-70

2. Gate Valves, Class 125, body and bonnet of ASTM B-62 cast bronze composition, with threaded ends, solid disc, copper silicon rising stem, brass packing gland, Teflon-impregnated packing and malleable handwheel.
   a. Stockham B-100 (RS)
   b. Crane 428
   c. Nibco T-111

B. Shut-off or sectional valves 2-1/2 inch and larger:

1. Gate Valves, non-rising stem, solid wedge disc, Class 125 iron body and bonnet, flanged ends, conforming to ASTM-A-126 Class B cast iron, bronze mounted, with Teflon impregnated packing and two-piece gland assembly.
   a. Stockham G-612
   b. Crane 461
   c. Nibco F619

2. Butterfly Valves shall be wafer lug type body, 200 psi CWP, conforming to ASTM A-126 Class B cast iron, with field replaceable EPDM sleeve, aluminum bronze disc, 410 stainless steel stem, and EPDM O-ring stem seals. Lever operated from 2-1/2 inch through 6 inch, above 6 inch gear operated.
   a. Lever operated: Stockham LG-712-BS3-E
      Demco NE-150-5214351
      Crane 44-BXZ-TL

   b. Gear operated: Stockham LG-722-BS3-E
      Demco NE-150-5214359-2098
      Crane 44-BXZ-G

C. Globe valves and angle valves 2 inch and smaller shall be Class 125, body and union bonnet of ASTM B-62 cast bronze composition, threaded, copper silicon alloy stem, replaceable Teflon disc, brass packing gland, Teflon impregnated packing.
D. Globe Valves
   1. Stockham B-13T
   2. Crane 7 TF
   3. Nibco T-211-Y

   Angle Valves
   1. Stockham B-216
   2. Crane 17TF
   3. Nibco T-311-Y

E. Globe Valves and angle valves 2-1/2 inch and larger shall be Class 125, OS&Y, rising stem, iron body bronze mounted with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, Teflon-impregnated packing, two-piece packing gland assembly, Teflon disc.

F. Globe Valves
   1. Stockham G-514T
   2. Nibco F-718-B

   Angle Valves
   1. Stockham G-515
   2. Nibco F-818-B

G. Check Valves
   1. Stockham B-319
   2. Crane 1707
   3. Hammond IB940

H. Check Valves
   1. Stockham G-931
   2. Crane 373
   3. Nibco F918-B

2.02 Balancing Valves

A. Heating Hot Water,
   1. Water circuit balancing valves in sizes 1/2-inch through 3-inch shall have cast bronze or cast copper alloy bodies with threaded end connections, or optionally cast iron body with flanged ends in sizes 2-1/2 inch and 3-inch. Valves 4-inch and larger shall have cast iron body with flanged ends. Valves shall be rated for an operating pressure of 250 psi minimum at 250 degrees F.
   2. Threaded valves to be brass venturi or ball or tapered plug type and shall provide positive shut-off. Flanged valves to be brass vane type or teflon disc globe type.
   3. Valves shall have levers, handwheels or manual adjusting knobs and position indicators, memory stops, and readout ports. For insulated pipe read out ports shall be extended beyond insulation.
   4. Each valve shall include factory furnished, two-piece molded insulation.
   5. Bell & Gosset Circuit Setter type CB, Armstrong Type CBV-I, CBV-II, Preso B-Plus.
   6. Furnish manufacturer=s portable read out kit with carrying case.
2.03 Safety and Release Valves

A. Valve size shall be designated by the nominal size of the inlet connection. Size, capacity, pressure relief setting, accumulation, and blowdown, as shown on the drawings and schedules.

B. Heating Hot Water: Kunkle 137

PART 3 – EXECUTION

3.01 Installation

A. Installation of Valves:

1. Valve sizes and types shall be as shown on the drawings. For 2-1/2-inch pipe size, connections may be flanged, or screwed.

2. Before installing valves, blow out with compressed air and clean with water or steam.

3. Install valves only in accessible locations. Manually operated valves shall be positioned so that stems are in any suitable angle from horizontal to upright position.

4. Install lift check valves in horizontal position. Swing check valves may be installed in vertical lines with upward flow.

5. All exposed valves requiring frequent operation and located more than 8-feet above the floor shall be fitted with chains and chain operators extending to within 6-feet 0-inches of the floor.

6. Except for Steam service, all hand-controlled line valves 2 inch and smaller shall be ball or gate valves, except that where frequent operation is required ball valves shall be used.

7. Except for Steam service, all hand controlled line valves 2-1/2 inch and larger shall be gate or butterfly valves.

8. Angle valves may be used for making a 90 degree turn in a line in lieu of a globe valve and elbow.

9. Where hand throttling is required provide globe or angle valves, unless otherwise shown.

10. Install all globe and angle valves to close against the pressure.

11. Line valves larger than 2” shall be supported at the valve in addition to regularly spaced pipe supports.

12. Flanges, Gaskets, Flange Bolts, nuts and washers shall be suitable for the intended service and shall be in accordance with ANSI/ASME B31.9-1982 Building Service Piping.

END OF SECTION
SECTION 15170

INSTRUMENTATION

PART 1 – GENERAL

1.01 Related Documents

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 Scope

A. This Section includes meters and gages used in mechanical systems.

1.03 Work Included In This Section

A. Materials, equipment fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Thermometers
2. Pressure gauges
3. Test plugs

1.04 Related Requirements

A. Division 15 piping Sections contain requirements that relate to this Section.

B. Meters and gages furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 15 sections.

1.05 Submittals

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

C. Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

D. Maintenance data to include in the "Operating and Maintenance Manuals" specified in Division 1 Section "Project Closeout." Include data for the following:

1. Test plugs.

1.06 Quality Assurance

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.
B. Design Criteria: The Drawings indicate types, sizes, capacities, ranges, profiles, connections, and dimensional requirements of meters and gages and are based on the specific manufacturer types and models indicated. Meters and gages having equal performance characteristics by other manufacturers may be considered, provided that deviations do not change the design concept or intended performance as judged by the University Representative. The burden of proof for equality of meters and gages is on the proposer.

PART 2 – PRODUCTS

2.01 Manufacturers

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

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

1. Ashcroft
2. Palmer
3. Treice
4. Wexler
5. Marsh
6. Peterson
7. Watts
8. Bell & Gossett
9. Fischer & Porter
10. Taco
11. Wallace & Tiernan
12. Badger
13. Dwyer
14. Hersey
15. Or equal

2.02 Thermometers, General

A. Scale Range: Temperature ranges for services listed as follows:

1. Hot Water: 30 to 300 deg F, with 2 deg scale divisions (0 to 150 deg C, with 1 deg scale divisions).
2. Condenser Water: 0 to 160 deg F, with 2 deg scale divisions (minus 18 to 70 deg C, with 1deg scale divisions).

B. Accuracy: +/- 1 percent of range span or +/- one scale division to maximum of 1.5% of range span.

2.03 Liquid-In-Glass Thermometers
A. Description: ASTM E 1, liquid-in-glass thermometer.

B. Case: Die-cast and aluminum-finished in baked-epoxy enamel, glass front, spring secured, 9 inches (230 mm) long.

C. Adjustable Joint: Finished to match case, 180-degree (3.1 rad) adjustment in vertical plane, 360-degree (6.3 rad) adjustment in horizontal plane, with locking device.

D. Tube: Red-reading mercury-filled with magnifying lens.

E. Tube: Red-reading, organic liquid-filled instead of mercury-filled, with magnifying lens.

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

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

2.04 Direct-Mounting Filled System Dial Thermometers

A. Description: Vapor-actuated universal-angle dial thermometer.

B. Case: Drawn steel or cast aluminum, with 4-1/2-inch (115-mm) diameter glass lens.

C. Adjustable Joint: Finish to match case, 180-degree (3.1 rad) adjustment in vertical plane, 360-degree (6.3 rad) adjustment in horizontal plane, with locking device.

D. Thermal Bulb: Copper with phosphor-bronze Bourdon pressure tube.

E. Movement: Brass, precision geared.

F. Scale: Progressive satin-faced nonreflective aluminum with permanently etched markings.

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

2.05 Remote-Reading, Filled-System Dial Thermometers

A. Description: Vapor-actuated remote-reading dial thermometer.

B. Case: Drawn steel or cast aluminum, with 4-1/2-inch (115-mm) diameter glass lens.

C. Movement: Brass, precision geared.

D. Scale: Progressive satin-faced nonreflective aluminum with permanently etched markings.

E. Tubing: Bronze double-braided armor-over-copper capillary of length to suit installation.

F. Bulb: Copper with separable socket for liquids; averaging element for air.

2.06 Bimetal Dial Thermometers

A. Description: Direct-mounted universal-angle bimetal dial thermometer.

B. Case: Stainless steel with 5-inch (125-mm) diameter glass lens.

C. Adjustable Joint: Finish to match case, 180-degree (3.1 rad) adjustment in vertical plane, 360-degree (6.3 rad) adjustment in horizontal plane, with locking device.
D. Element: Bimetal coil.
E. Scale: Satin-faced nonreflective-aluminum with permanently etched markings.
F. Stem: Stainless steel for separable socket, of length to suit installation.

2.07 Insertion Dial Thermometers
A. Description: Bimetal dial thermometer.
B. Dial: 1-inch (25-mm) diameter.
C. Case: Stainless steel.
D. Stem: Dustproof and leakproof 1/8-inch (3-mm) -diameter tapered-end stem with nominal length of 5 inches (125 mm).

2.08 Thermometer Wells
A. Description: Brass or stainless-steel thermometer well.
B. Pressure Rating: Not less than piping system design pressure.
C. Stem Length: To extend 2 inches (50 mm) into fluid.
D. Stem Length: To extend to center of pipe.
E. Extension for Insulated Piping: 2 inches (50 mm) nominal, but not less than thickness of insulation.
F. Threaded Cap Nut: With chain permanently fastened to well and cap.

2.09 Pressure Gages
A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage, with bottom connection.
B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch (115-mm) -diameter glass lens.
C. Connector: Brass, 1/4-inch (DN 8).
D. Scale: White-coated aluminum, with permanently etched markings.
E. Accuracy:+/- 1% of range span.
F. Range: Conform to the following:
   1. 30 inches Hg (100 kPA) of vacuum to 2 times operating pressure.

2.10 Pressure Gage Accessories
A. Syphons: 1/4-inch (DN 8) straight coil of brass tubing with threads on each end.
B. Snubbers: 1/4-inch (DN 8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.11 Test Plugs
A. Description: Nickel-plated brass-body test plug in 1/2-inch (DN 15) fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig (3450 kPa) minimum.

D. Core Inserts: 2 self-sealing valve types, suitable for inserting a 1/8-inch (3-mm) outside-diameter probe from a dial thermometer or pressure gage.

E. Core Material: According to the following for fluid and temperature range:
   1. Air, Water, Oil, and Gas: 20 to 200 degree F (minus 7 to 93 degree C), neoprene rubber.
   2. Air and Water: Minus 30 to 275 degree F (minus 35 to 136 degree C), ethylene-propylene-diene-terpolymer (EPDM) rubber.

F. Test-Plug Cap: Gasketed and threaded cap, with retention chain.

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

H. Pressure Gage and Thermometer Ranges: Approximately 2 times systems operating conditions.

PART 3 – EXECUTION

3.01 Meter and Gage Applications

   A. General: Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.

3.02 Meter and Gauge Installation, General

   A. Install meters, gages, and accessories according to manufacturers' written instructions for applications where used.

3.03 Thermometer Installation

   A. Install thermometers and adjust vertical and tilted positions.

   B. Install in the following locations and elsewhere as indicated:
      1. At inlet and outlet of each hydronic zone.
      2. At inlet and outlet of each hydronic boiler and chiller.
      3. At inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
      4. At inlet and outlet of each hydronic heat exchanger.
      5. At inlet and outlet of each hydronic heat recovery unit.
      6. At inlet and outlet of each thermal storage tank.

   C. Remote-Reading Dial Thermometers: Install in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

   D. Thermometer Wells: Install in vertical position in piping tees where thermometers are indicated.
1. Install wells with stem extending minimum of 2 inches (50 mm) into fluid.
2. Install wells with stem extending to center of pipe.
3. Fill wells with oil or graphite and secure caps.

3.04 Pressure Gage Installation
A. Install pressure gages in piping tee with pressure gage valve located on pipe at most readable position.
B. Install in the following locations and elsewhere as indicated:
   1. At suction and discharge of each pump.
   2. At discharge of each pressure-reducing valve.
   3. At building water service entrance.
   4. At chilled water and condenser water inlets and outlets of chillers.
C. Pressure Gage Needle Valves: Install in piping tee with snubber. Install syphon instead of snubber for steam pressure gages.

3.05 Test Plug Installation
A. Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

3.06 Connections
A. Piping installation requirements are specified in other Division 15 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.
B. Install gages adjacent to machines and equipment to allow servicing and maintenance.

3.07 Adjusting and Cleaning
A. Adjusting: Adjust faces of gages to proper angle for best visibility.
B. Cleaning: Clean windows of gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION
SECTION 15200

NOISE, VIBRATION, AND SEISMIC CONTROL

PART 1 – GENERAL

1.01 Description

A. Provide complete systems of vibration isolation and seismic restraints for equipment, piping and ductwork.

B. The work of this Section includes, but is not limited to:
   1. Seismic Restraints
   2. Vibration Isolators
   3. Flexible Pipe Connections
   4. Field Dynamic Balancing

1.02 Work Included

A. Objective: It is the objective of this specification to provide the necessary design for the avoidance of excessive noise or vibration in the building due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork or conduit.

B. Description of Work: Furnish, install, assemble, set up, test (hereinafter “provide”) the following systems and equipment in accordance with the Contract Documents.
   1. Isolation of mechanical equipment including but not limited to fan power boxes.
   2. Isolation for ductwork and piping (including but not limited to domestic and industrial hot and cold water, waste, soil, vent, and lab utilities, and including all piping connected to vibrating equipment).
   3. Supervision and inspection of installation of vibration isolation to equipment.
   4. Provision of all Motion Restraints required by applicable codes for noise and vibration control equipment/systems specified herein.
   5. Coordination of Airtight Installation requirements at Mechanical Rooms.
   6. Dynamic balancing of equipment.

1.03 Related Work In Other Divisions and Sections

A. Concrete, Division 3
B. Thermal and Moisture Protection, Division 7
C. Finishes, Division 9
D. Section 15090, Supports and Anchors
E. Electrical, Division 16
1.04 Quality Assurance

A. General:

1. Anchor, support, and brace all equipment and systems to resist seismic forces as specified hereinafter.


3. Where anchorage support and bracing for various manufactured and fabricated items and systems are detailed and scheduled on the drawings, provide as shown.

4. For anchorage, support and bracing not detailed, provide in accordance with one of the following: SMACNA, NUSIG, OSHPD. Where these guidelines are not applicable, submit details of anchors, supports and bracing complete with calculations. Details and calculation shall be signed and stamped by a Structural Engineer licensed in the state having jurisdiction over the project.

B. Testing Laboratory:

1. Testing Laboratory shall test expansion bolts as specified herein.

C. Reference Standards:

1. Standards: Provide equipment in accordance with the latest edition and revisions of all applicable standards and specifications of all appropriate agencies including, but not limited to, the following:
   
a. ARI - Air Conditioning and Refrigeration Institute
      (3) RI 275 - 1997 Standard for Application of Sound Rating Levels of Outdoor Unitary Equipment.
      (4) ARI 280 - 1995 Standard for Requirements for the Qualification of Reverberant Rooms in the 63 Hz Octave Band.

b. ASTM - American Society for Testing and Materials


c. ASA - Acoustical Society of America/ANSI


(4) ANSI S12.30-1990 (R1997) American National Standard Guidelines for the Use of Sound Power Standards and for the Preparation of Noise Test Codes


(7) ANSI S12.54-1999 ISO 3744:1994 NAIS Standard Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane

d. AMCA - Air Movement and Control Association International, Inc.

(1) AMCA Standard 300-96, Reverberant Room Method for Sound Testing of Fans

(2) AMCA Standard 320-98, Laboratory Methods of Sound Testing Fans Using Sound Intensity

(3) ANSI/AMCA Standard 330-97 (ANSI/ASHRAE 68-99), Laboratory Method of Testing to Determine the Sound Power in a Duct

e. AWS - American Welding Society, Inc.

(1) AWS D1.1 - 2002 Structural Welding Code - Steel

f. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers

(1) 1999 HVAC Applications Manual, Chapter 46

g. SMACNA - Sheet Metal & Air Conditioning Contractor's National Association, Inc.

(1) Rectangular Industrial Duct Construction Standards 1st edition, 1980
h. National Uniform Seismic Installation Guidelines (NUSIG)

D. Codes: Perform installation in accordance with all applicable international, federal, state, county, municipal and local codes and regulations.

E. Conflicts: Present any conflicts between codes, regulations, specifications and/or requirements at least thirty (30) days prior to the commencement of the scheduled work.

F. Schedules: See contents of this Section for specific specifications and schedules of vibration isolators, frames and static deflections. Also see equipment support schedule on the drawings.

G. Product Suppliers: All vibration isolation devices, equipment bases and frames for equipment and piping furnished under Division 15 shall be designed and furnished by no more than two different isolator manufacturers and no single vibrating element shall be isolated by the products of more than one isolator manufacturer.

H. Supervision: The installation of all vibration isolation units, and associated hangers and bases shall be under the direct supervision of the vibration isolation manufacturer's representative.

I. Vibration isolation hardware must not be concealed until approval is obtained from the owner's field representative.

J. Verify specified clearances; plumb installation of hanger rods and lack of interference (e.g., no contact is permitted with gypsum board, framing, ceiling wires, conduit, ducts and piping).

K. Verify proper vibration isolator loading and deflection.

L. Vibration isolation supplier to generate punch list report for Construction Administrator's review.

1.05 Coordination

A. Coordinate with Finish Systems, Piping Systems and Equipment, Water Cooling and Heating, Plumbing Systems, Heating, Ventilating and Air Conditioning and Electrical sections, including but not limited to Section 16071, for installation of Vibration Isolation. Coordinate with Concrete trade for equipment inertia bases. Coordinate Work of this Section with all other impacted trades.

1.06 Submittals

A. Descriptive Data - Submit the following:

1. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications and schedules herein. Include load versus deflection curves.

2. An itemized list showing the items of equipment, piping, etc., to be isolated, the isolator type and model number selected, isolator loading and deflection, wire diameter and number of coils in springs, and references to specific shop drawings showing frame construction where specified.

3. Written approval of the frame design to be used, obtained from the equipment manufacturer.

B. Seismic Bracing
1. Where OSHPD pre-approved bracing systems will be employed, submittals shall include:
   a. Approval identification number.
   b. System component brochure describing components used and detailed installation
      instruction.
   c. Loads to be transmitted to structure at anchor point.

2. Where anchorage, support and bracing are not detailed on the drawings and pre-approved systems are
   not used, Contractor shall submit designs and calculations of proposed systems. Submittals shall include:
   a. Detailed sketches showing system to be installed.
   b. Written instructions from the vibration isolation manufacturer as to the proper installation and
      adjustment of vibration isolation devices, including hangers and bases; alternatively the
      equipment may be installed by the vibration isolation manufacturer.
   c. For each Motion Restraint, a stress analysis prepared by a Structural Engineer licensed to
      practice in the state of Project jurisdiction.
   d. Provide sufficient detail to permit architect and authorities having jurisdiction to verify
      compliance with all applicable Codes and these specifications.
   e. For vibration isolation used with equipment over 300 pounds, provide calculations for:
      (1) shear,
      (2) pull-up,
      (3) primary overturning and
      (4) secondary overturning.
      (5) A certification in the calculation cover sheet stating:
         a) “These calculations demonstrate the system detailed complies with the
            requirements of Chapter 16A of the California Building Code. The
            mechanical system in which this bracing will be applied is [rigid] [non-
            rigid] as defined in Chapter 16A.” (Choose applicable description.)

3. An itemized list of all items of equipment to be fitted with flexible piping and/or duct connections.
   a. Flexible piping and/or duct submittals shall contain all information and calculations to
      demonstrate conformance and suitability for the equipment operating conditions including but
      not limited to pressure, temperature, capacity, mounting, maintenance, etc.
   b. Submittals shall also include independent acoustical test data demonstrating at least 20 dB
      attenuation of vibration accelerations at typical blade passage frequencies.

C. A schedule of airtight and resilient sleeves which will be used where ducts, pipes and/or conduit penetrate building
   construction, including where necessary in order to maintain airtight mechanical rooms.

D. Certified acoustic test data for terminal units. Provide maximum casing radiated and discharge noise PWL and SPL in
   accordance with the specified procedures. Provide acoustical test data for in duct insertion loss.

E. Shop Drawings - Submit the following and secure approvals prior to fabrication:
1. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, support point locations, etc.

2. Drawings showing methods for suspensions, support, guides, etc., for piping and ductwork, etc.

3. Drawings showing methods, for isolation of ducts, pipes, etc., piercing walls, slabs, beams, etc.

4. Drawing showing methods numbers and details of Motion Restraints and anchors for equipment, frames, isolators, piping, ductwork, etc., including calculations as above.

5. Details for concrete and steel bases including anchor bolt locations.

6. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, showing compliance with Code and coordination with the Project Architectural, Structural and Mechanical Documents.

7. Details of flexible piping and duct connections for all typical conditions listed in the schedule provided above.

F. Anchorages and Supports

1. Where Contractor-proposed substitutions change the weight, size, configuration or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, the Contractor shall submit calculations for proposed anchors and supports, and install them as shown in these calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.

2. Where contractor-proposed substitutions are claimed to have no effect on anchors and supports detailed on the Contract Documents, Contractor shall submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.

3. Contractor shall submit details and calculations for all embedded inserts, drilled inserts and other fasteners for attachments of suspended components showing the load-carrying capacity of each device calculated in accordance with Chapter 16 of the California Building Code. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.

4. For all anchorages and supports not detailed on the Contract Documents, Contractor shall submit details and calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.

PART 2 – PRODUCTS

2.01 General Properties

A. Deflection: Vibration isolators shall have either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

B. Range: Isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range 60 percent above the design deflection.

C. Ratio: Ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 1.3.

D. Nested: Unless specifically noted, nested spring designs shall not be permitted.

E. Uniformity: Vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ by more than 10 percent.
F. Isolation: Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems within 10% up to 50 dB or greater at all frequencies above 150 Hz.

G. Protection: Isolators installed outdoors shall be designed for such exposure suitable to the Project conditions.
   1. Springs shall be coated in neoprene or PVC, epoxy coated, or shall be hot dip galvanized.
   2. All neoprene mountings shall have a Shore-A hardness of 30 to 50, after minimum aging of 20 days or corresponding oven-aging.

H. Internal Isolation: Where vibration isolators and associated equipment frames have been specified herein for “package” air-handling units which are available with “internal” isolation; the contractor shall comply with the following:

I. Isolators shall be selected by the supplier on the basis of the static and dynamic loads actually supported. Dynamic loads include those due to: Wind, fluid flow, thrust, and rotational inertia. Select each isolator independently for the load distribution on the equipment base, duct or pipe support.

J. All spring isolators shall be laterally stable and have leveling bolts. Spring isolators shall have a minimum additional “travel” to full compression of half the rated deflection. The ratio of lateral to vertical stiffness shall be 0.9 minimum and 1.5 maximum.

K. Spring isolation hangers shall incorporate a resilient neoprene element of 1/4-inch minimum thickness to prevent solid contact between the spring and isolator housing.

L. Equipment requires a minimum of four isolators, one at each corner.

M. Provide thrust restraints on fans over 3-inches w.g. static pressure. Thrust restraints shall have the same deflection as isolators supporting the fan.

N. Confirm suitability of vibration isolation system with equipment manufacturers wherever necessary.

O. Equipment support frames and bases shall be selected by the supplier in order to use the specified isolators. Design intent is to use unhoused springs with independent snubbers, or where indicated, slack cables for restraint purposes.

P. All neoprene material to have anti-ozone and anti-oxident additives.

Q. Snubbers must not limit the vibration isolation capability during normal operation. Where steel limit stops are used, provide 1/4-inch-thick neoprene to prevent metal-to-metal contact.

R. Where indicated, slack cable restraints are to be installed at each isolator. Size slack cables and anchors to support entire equipment load. Isolators located at the corners of equipment require two slack cables perpendicular to one another in the horizontal plane. The allowable equipment movement must be restricted to prevent springs from disengaging their mountings.

2.02 Acceptable Manufacturers

A. Pipe Bracing Systems:
   1. NUSIG
   2. Super Strut
   3. Or equal
B. Vibration Isolation Control Systems:

1. Mason Industries
2. Kinetics Noise Control
3. M.W.Sausse & Co. - Vibrex
4. Or equal

2.03 Isolator Description

A. Application Cross-Reference: For application and the specific static deflection requirements of the isolators described below, refer to schedules and references elsewhere herein.

1. Type MS: Bare spring type equipped with leveling bolts and with two layers of ribbed or waffled neoprene pad separated by a 1/16" galvanized steel plate under the base plate. Acceptable Products: Mason Type SLFH, Kinetics Type FDS-B, Vibrex Type RMS, and RMSG.

2. Type MSL: Restrained with two layers of ribbed neoprene pad with 1/16" galvanized steel separator between layers under the base plate. Provide limit stops to prohibit spring extension if the load is removed. These stops shall serve as rigid blocking during erections so that the installed and operating heights shall be the same. Provide a minimum of 2" clearance around restraining bolts and between the limit stops and the housing so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Acceptable Products: Mason Type SLR B, C, or 100 Series, Kinetics Type FLS, and Vibrex Type RMLS-EQ.

3. Type MSR: Captive spring mount. Acceptable product: Mason SSLFH, or equal, (no known equal).

4. HS: Suspension hangers having a steel frame and spring element in series with a 1-inch thick neoprene pad with integral grommet. The design static deflection under load shall be as shown on the schedule. The isolator shall be designed so hanger rod may be misaligned 15 degrees relative to the vertical without touching integral grommet inset in hanger box frame. Acceptable Products: Mason Type 30N, Kinetics Type SRH, and Vibrex Type HXA.

5. Type HD: Spring hangers, load transfer. Same as Type HS with washer and nut assembly and indicator for load transfer and deflection readout.

6. Type HN: Suspension hangers having a neoprene isolator unit having a minimum static deflection range of 0.25" to 0.5" designed to preclude contact of hanger rods with frame at up to 15 degree misalignment. Acceptable Products: Mason Type HD, Kinetics Type RH-B&C, and Vibrex Type HSS.

7. Neoprene isolator unit having a minimum static deflection range of 0.25" to 0.5". Acceptable Products: Mason Type ND, Kinetics Type RD, and Vibrex Type DD.

8. Type P: Pipe isolators with clamps attached to unhoused steel spring isolators with neoprene pads and independent seismic restraints to limit horizontal movement with neoprene padded snubbers to prevent metal-to-metal contact. Isolators and restraints must be capable of withstanding an acceleration of 1 g in all directions. Acceptable Product: Vibrex Type PG-EQ.

9. Type NSP: Neoprene pad. Waffled or ribbed. Typically 5/16 to 2" thick. Durometer of 50 maximum. Static deflection typically 0.05". Nominal design 40 durometer for 0.05" static deflection under 60 psi load. Provide steel load distribution plates. Size of pad to be selected by isolator supplier based on load per point. Acceptable Products: Mason Type SW, Kinetics Type NGB, and Vibrex Type ISO-Cube.

10. Type MND: Neoprene Mount, Deep Displacement. A machinery mount with a neoprene diagonal lattice structure located between steel base and support plates. Suitable for loads from 300 to 4000 lbs and for driving frequencies as low as 6 Hz. Capable of providing static deflections from 5/8” to 1” with
11. **Type BR:** Captive neoprene mounts capable of 0.20-inch static deflection in compression, 0.175-inch static deflection in tension and 0.125-inch deflection in shear. Acceptable Product: Mason Type BR.

12. **Corrosion Protection:** Steel parts of vibration isolators and seismic snubbers, except springs, shall be hot dipped galvanized in accordance with ASTM A123. Where steel parts are exposed to the weather, galvanized coating shall be at least 2 ounces of zinc per square foot of surface. Springs shall be neoprene coated.

### 2.04 Equipment Frames

**A. General Properties:** Mounting frames and/or brackets shall be hot dipped galvanized steel and shall be provided to carry the load of the equipment without stressing or causing mechanical distortion of the equipment. Each piece of equipment shall be supported at least four points by vibration isolators and restrained at least four locations by Motion Restraint.

1. **Rigid Steel (SB): Construction:**
   
   a. Rectangular with a minimum of four pieces of welded, wide flange structural steel with welded height saving brackets to accept the isolators. Additional frame members shall be provided as necessary to support pumps, motors, etc.

   b. The section depth of the frame members shall be greater than 1/10 of the length of the longest frame member, and shall be constant in all four perimeter frame pieces. Provide height saving brackets at all mounting locations to maintain a 1 inch clearance below the base.

2. **Floating Concrete Bases (CB): Construction:**
   
   a. Provide rectangular steel concrete pouring forms for floating concrete bases, with a minimum of four pieces of welded, wide flange structural steel with welded or integral height saving brackets to accept the isolators and to maintain a 1 inch clearance below the base. Additional frame members shall be provided as necessary to support pumps, motors, etc. Forms shall include minimum concrete reinforcing consisting of 2 inch bars welded in place on 6 inch centers running both ways in a layer 1.5 inch above the bottom. Provide forms with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured.

   b. The section depth of the frame members shall be greater than 1/12 of the length of the longest frame member, but not less than thickness listed in article 2.13, and shall be constant in all four perimeter frame pieces.

3. **Integrated Roof-mounted Spring and Frame (IRSF):** The integrated roof-mounted spring and frame assembly shall consist of a rectangular angle iron equipment frame supported by a type MS isolator on a steel channel roof perimeter. This assembly integrates with the roof insulation and canting to provide a weather-tight seal with cover plates removable for isolator inspection. The IRSF shall provide integral motion restraint and shall be available in stock modular construction components.

### 2.05 Equivalent Vibration Isolators and Equipment Frames

**A. Isolators**

**B. Acceptable subject to 2.03 above:**
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Mason Industries</th>
<th>Vibrex/ Sause</th>
<th>Lord Mechanical Products</th>
<th>Kinetics</th>
<th>Amber Booth</th>
<th>Vibration Mountings &amp; Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>Spring Mount</td>
<td>SLF*</td>
<td>RMS G*</td>
<td>B</td>
<td>FDS*</td>
<td>SW*</td>
<td>ADC*</td>
</tr>
<tr>
<td>MSL</td>
<td>Spring Mount with Limit Stop</td>
<td>SLR C series</td>
<td>RML S-EQ</td>
<td>--</td>
<td>FLS</td>
<td>CT</td>
<td>AWR</td>
</tr>
<tr>
<td></td>
<td>Under 1.5&quot; S.D. and under 200 pounds load per isol.</td>
<td>SLR A series</td>
<td>RMU J-EQ- SH</td>
<td>B</td>
<td>FLS</td>
<td>CT</td>
<td>AWR</td>
</tr>
<tr>
<td>HS</td>
<td>Spring Hanger</td>
<td>30N</td>
<td>HXA*</td>
<td>B</td>
<td>SRH*</td>
<td>BSRA*</td>
<td>SH*</td>
</tr>
<tr>
<td>HD</td>
<td>Spring Hanger</td>
<td>PC30N*</td>
<td>PHXA</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>HN</td>
<td>Neoprene Hanger</td>
<td>HD*</td>
<td>HSS*</td>
<td>--</td>
<td>RH*</td>
<td>HRD*</td>
<td>RHD*</td>
</tr>
<tr>
<td>MN</td>
<td>Neoprene Mount</td>
<td>ND*</td>
<td>HXA</td>
<td>--</td>
<td>RD*</td>
<td>RVD*</td>
<td>RD*</td>
</tr>
<tr>
<td>MND</td>
<td>Neoprene Mount, Deep Deflection*</td>
<td>--</td>
<td>--</td>
<td>Lattice Mount</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>NSP</td>
<td>Neoprene</td>
<td>W, WM*</td>
<td>R*</td>
<td>--</td>
<td>NPS*</td>
<td>SP-NR*</td>
<td>Shear-flex</td>
</tr>
<tr>
<td>MSR</td>
<td>Captive Spring Mount</td>
<td>SSLFH</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

*Unrestrained isolation systems require separate Motion Restraint as specified below.

C. Frames and Curbs

1. Acceptable subject to 2.04 above:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Mason Industries</th>
<th>Vibrex/ Sause</th>
<th>Lord Mechanical Products</th>
<th>Kinetics</th>
<th>Amber Booth</th>
<th>Vibration Mountings &amp; Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Rigid Steel Base</td>
<td>MSL/WFSL</td>
<td>RMSB</td>
<td>SFB</td>
<td>B</td>
<td>WFB-AC</td>
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<tr>
<td>CB</td>
<td>Floating Concrete Base</td>
<td>BMK</td>
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</tr>
<tr>
<td>IRSF</td>
<td>Integrated Roof Mount</td>
<td>RSC</td>
<td>ESR</td>
<td>B</td>
<td>B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.06 Motion Restraints

A. Objective: Provide motion restraining devices at all vibration isolated piping and equipment. Design restraints to comply with applicable Code in Project Jurisdiction.

B. General properties: Restraints shall permit adjustment during installation to insure sufficient clearance between vibration isolated element and rigid restraining device. Restraints at base supported equipment shall include resilient neoprene pads at all potential contact areas between isolated equipment and rigid restraining element.

C. Equipment, equipment bases and concrete inertia bases shall be restrained against excessive movement during a seismic event by the use of resilient snubbers designed to resist forces in accordance with Title 24 requirements. The steel members of the snubbers shall be designed to yield but not fail under these design conditions. Calculations by a Registered Professional Engineer, or certified test reports from a nationally recognized independent test laboratory shall be submitted which verify the capacity of each snubber.

D. Restraint Description

1. Restraining devices at base supported vibration isolated equipment using MS-type springs shall be as manufactured by Mason Industries, type Z-1011 or equal by Vibrex, Amber Booth or Kinetics.

2. Coordinate restraint bolt locations with the structural and mechanical drawings and conditions.

3. Restraints at suspended piping and equipment shall consist of stainless steel cables together with neoprene snubbers arranged to achieve the required all-directional restraint and sized to resist the forces defined. Shop Drawings shall indicate proposed method for achieving vertical restraint for ceiling suspended piping. Cables shall have sufficient slack to avoid short circuiting the vibration isolators.

4. Snubbers shall be welded steel, and shall be attached to the supporting structure in a manner consistent with anticipated loads. Such attachments shall meet current State Building Codes.

5. Snubbers shall be placed around equipment to limit lateral or vertical movement at each snubber to one-half inch (2”). A minimum of four (4) snubbers shall be installed around each piece of resiliently supported equipment.

6. Snubbers shall include resilient pads to cushion any impact, and shall be installed so as to be out of contact during equipment operation.

2.07 Vibration Isolator Application and Schedules - Equipment

A. General: The isolator type scheduled shall be furnished and installed for the following mechanical equipment in accordance with Part 3 herein, loaded to yield the specified deflection per the schedule below at each isolator. The contractor shall verify that the dead load deflection of the structure at each isolator location is less than 0.25 times the isolator static deflections scheduled herein. In the event that the dead load deflection of the structure at any isolator location is greater than 0.25 times the scheduled isolator static deflection, the contractor shall increase the static deflection of such isolators to be at least 4.0 times the dead load deflection of the structure.

B. Application Schedule: See M5.04.

2.08 Piping and Duct Resilient Support and Suspension

A. Execution Cross-Reference: Refer elsewhere in this Section for the requirements of Resilient Penetrations and Flexible Connections. Refer to Part 3 for the extent of the resilient piping support cited below.

1. At pipe anchors for piping attached to vibrating equipment provide Types MN or HN to avoid direct contact of piping with building.
2. Pipe sway braces where required and attached to vibrating equipment shall utilize neoprene elements of 40 durometer maximum and of 3/8” minimum thickness, Type MN shall be used where such braces are required to accommodate both tension and compression forces.

2.09 Flexible Duct Connectors

A. Fabric: Flexible connection fabric shall be a non-combustible water-proof, airtight, glass fabric, one side coated with Neoprene, weight 30 ounce per square yard. For ducts operating at over 100 deg F and for acid resistant applications, flexible fabric shall be 30 ounce Neoprene coated glass fabric. All fabric shall meet the applicable Code of the project jurisdiction. See Section 15840, Air Distribution Systems for additional material and installation requirements. The minimum clear dimension of the flexible connectors, not including the clamping section, shall be 6 inches.

B. Acceptable Manufacturers:
   1. Vent Fabrics, Inc.
   2. Duro-Dyne
   3. Advance Elastomeric Systems
   4. or equal, as specified elsewhere in Division 15.

2.10 Flexible Piping Connectors

A. Application: Provide elastomeric flexible piping connections between piping and vibrating equipment including but not limited to: pumps, cooling towers, air handling units coils and compressors.

1. Provide flexible piping connections to units listed above and similar at all connection points via flexible neoprene connectors consisting of multiple plys of nylon tire cord fabric and neoprene. Neoprene elements shall form at minimum a dual sphere muffler construction at each connection. Connectors up to and including 1-1/2” diameter may have threaded ends. Connectors 2” in diameter or larger shall be manufactured with floating metal flanges recessed to lock the connector's raised face neoprene flanges.
   a. Inside diameter 2-1/2 inches and larger: Mason Type Safeflex SFDEJ.
   b. Inside diameter 3/4 inch to 2 inches: Mason Type MFTFU.
   c. Inside diameter 1/2 inch: Mason Type RMM.

2. Connectors shall be rated a minimum of 150 psi at 220 degree F. Flanged equipment shall be directly connected to neoprene elbows in the size range of 2-1/2” to 12” diameter if the piping makes a 90 degree turn at the equipment. All straight through connections shall be made via twin sphere configuration per A above.

3. Provide steel restraint cables with fittings, nuts, steel washer, and acoustical washers where elongation would exceed manufacturer's limits at operating pressure. Select thrust restraints incorporating steel springs having an operating static deflection that is equal to the static deflection of vibration isolators supporting the equipment. Provide a minimum of two thrust restraints to restrain forces acting along the axis of thrust and prevent skewing or rotation of equipment during operation. Elastomeric connectors shall have either tubular or spherical configuration as required or indicated. Spherical type straight connectors shall have two spheres. Elastomeric elbow connectors will not be acceptable.
   a. Compression thrust restraint: Mason WBI.
   b. Tension thrust restraint: Mason WBD.

B. Metallic hoses:
1. Provide subject to A above only where required by the Mechanical Engineer and subject to prior approval by Consultant and the Mechanical Engineer. Provide two each at every location where A applies above.

2. Provide flexible connectors fabricated of Grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless steel braid restraining and pressure cover. Stainless steel grades shall be 304, 316, or 321 as required for the application. Live lengths shall be as indicated, but not less than that recommended by the manufacturer for continuous vibration application.

3. Acceptable:
   a. Type BBS, SS or BBF by Mason Industries, Inc.
   b. Type BBS, SS or BBF by Mercer Rubber Company
   c. Metal-Flex by Amber/Booth Company
   d. Stainless steel flexible connectors by DME, Inc.
   e. Type MFP by Vibration Mountings & Controls, Inc.

2.11 Resilient Penetrations

A. For piping or ductwork, (Field Fabricated Method):

1. Sleeves: Sleeves of appropriate gage galvanized sheet metal shall be formed to at least the thickness of the penetrated construction and 3/4” to 1” larger in each cross-sectional dimension than the penetrating element.
   a. Acceptable:
      (1) Century-Line Sleeves by Thunderline Corporation
      (2) Custom by Contractor

2. Batt: Glass fiber of batt or mineral wool, 1 to 3 lb./cu. ft. density.
   a. Acceptable Manufacturers
      (1) Certain-Teed
      (2) Johns-Manville
      (3) Owens-Corning

3. Acoustical Sealant:
   a. Acceptable Manufacturers:
      (1) DAP
      (2) Pecora
      (3) Tremco
      (4) U.S. Gypsum

4. Firestop Sealant:
a. Where duct and piping penetrate sound isolation partitions or walls around mechanical rooms, the penetration shall have a maximum clearance of 3/4-inch on all sides, ¼" where exposed to view in public areas, and shall be packed with glass fiber and caulked airtight on both sides with acoustically rated sealant, or equal. Acoustic sealant shall be fire rated to meet UL designs for applicable fire rated wall assemblies. For smoke or fire rated partitions see SECTION 15010, "MECHANICAL GENERAL REQUIREMENTS".

b. Fully hardened firestop caulk shall develop a Shore A hardness of no greater than 35.

c. Acceptable, subject to approval for intended application by Authorities Having Jurisdiction:

   (1) G.E. Pensil 100 Firestop Sealant
   (2) Tremco Fyre-Sil Silicone Fire-stop Construction Sealant

B. For piping penetrations (Factory Fabricated Component Method):

   1. A factory-fabricated sleeve assembly with outer sleeve of sheet metal and inner resilient liner of moisture and vermin-resisting felt neoprene, glass fiber or foam rubber 2 to 3/4" thick and bonded to the sheet metal sleeve. Sleeve inside diameter shall be equal to outside diameter of penetrating element. Sleeve length shall be at least equal to the thickness of the penetrated construction. Sleeve shall be set and caulked airtight in penetrated construction and clamped tightly around penetrating element.

   2. Acceptable:

      a. Mason Type SWS
      b. Peabody Type PS-1-D
      c. Potter-Roemer PR-Isolator
      d. Stoneman Engineering Trisolator

   3. Where required, a fire rated factory fabricated sleeve and inner resilient liner of solid rubber links may be substituted for the preceding when installed in strict accordance with the manufacturer’s instructions.

      a. Acceptable, subject to by Authorities Having Jurisdiction:

         (1) Link Seal by ThunderLine Corp.

2.12 Concrete Inertia Bases

A. Concrete inertia base comprised of reinforced structural steel perimeter with motor slide rails, height reducing brackets, pipe elbow supports, reinforcing and equipment attachments as required.

B. Minimum concrete thickness as follows:

<table>
<thead>
<tr>
<th>MOTOR (HP)</th>
<th>THICKNESS (INCHES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-15</td>
<td>6</td>
</tr>
<tr>
<td>20-50</td>
<td>8</td>
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<tr>
<td>60-75</td>
<td>10</td>
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<tr>
<td>100-250</td>
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</tr>
</tbody>
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PART 3 – EXECUTION

3.01 Installation/Application/Performance/Erection

A. Seismic Restraint Systems: Maintain equipment, piping, ductwork in a captive position. Do not short circuit vibration systems or transmit objectionable vibration or noise. Structural bases shall be reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transfer into equipment.

B. Vibration Isolation: Mechanical and associated electrical machinery, piping and ductwork shall be mounted on vibration isolators and seismic snubbers as indicated or specified and required to minimize transmission of vibrations and structureborne noise to the building structure or spaces. All mechanical equipment, unless otherwise noted, shall be isolated from the structure by means of resilient vibration and noise isolators.

1. Rotating and reciprocating machinery shall be balanced statically and dynamically.

C. After installation and before equipment start-up an authorized representative of the manufacturer shall visit the site, and shall inspect each isolator and certify in writing that each is installed in accordance with the manufacturer’s instructions. Make all adjustments and corrections required by the manufacturer's representative to enable this certification.

D. Ductwork Seismic Restraints:

1. Support and brace all ductwork not otherwise detailed on the Contract Drawings in accordance with NUSIG.

2. Diffuser Bracing: For suspended type ceilings, ceiling mounted air terminals or services shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners. In addition, two No. 12 gauge slack wires shall be connected from diffusers to the structure above. Connect wire to diffusers at diagonally opposed corners.

3. Support and seismically brace all duct mounted devices including but not limited to VAV/CAV terminal boxes, fan powered boxes and sound attenuators.

E. Bases: Equipment shall be set on concrete bases, minimum of 4-inches high.

3.02 Field Quality Control

A. Testing and Inspection: See SECTION 01450.

B. Testing of Concrete Anchors: Anchors drilled into concrete and which are to be loaded in tension (pull-out) will be proof-tested by the Owner to two times the maximum allowable load. 50% of all anchors will be proof-tested. In the event of a single failure, testing of all remaining anchors will be performed as directed by the Architect [and approved by OSHPD]. Additional testing required because of a test failure shall be paid for by the Contractor.

C. Field Balancing:

1. Dynamic balancing of certain critical rotating equipment is required; see Section 15010.

   a. Maximum Permissible Machinery Vibration Levels:

   b. Mechanical balance of rotating equipment as shown shall be field tested with final drives and couplings in place and with the units in normal operation.

   c. Overall vibration amplitude 0.003-inch maximum peak-to-peak, for frequencies below 10 cycles/second (600 rpm) and 0.1-inch/second maximum peak velocity for frequencies above 10 cycles/second (600 rpm).

   d. Take measurements on bearing housings (not end caps) or other heavy structural element
directly connected to bearing housing at both ends of each unit.

e. Pulley runout in radial and axial directions shall be less than 0.001-inch.

f. Correct and retest equipment exceeding the limits for compliance.

3.03 Inspection of Conditions

A. Examine related Work and surfaces before starting Work of this Section. Report to the Architect, in writing, conditions which will prevent proper provision of this work. Beginning the Work of this Section without reporting unsuitable conditions to the Architect constitutes acceptance of such conditions by Contractor. Perform any required removal, repair, or replacement of this Work caused by unsuitable conditions at no additional cost to the Owner.

3.04 General Installation Requirements

A. Stress: Installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.

B. Prior Approval: The Contractor shall not install any equipment, duct or piping which makes rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes, but is not limited to slabs, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems.

C. Rigid Contact: Prior to installation, the Contractor shall bring to the Architect's attention any conflicts between trades which will result in unavoidable rigid contact at equipment or piping or ducts, as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

D. Discrepancies: Prior to installation, the Contractor shall bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

E. Protection: Isolators exposed to the outdoors during construction shall either be designed for such exposure or shall be protected by suitable means.

F. Access: The Contractor shall obtain inspection and approval from the Architect of any installation to be covered or enclosed, prior to such closure.

G. Instructions: The Contractor shall obtain written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices; alternatively, the equipment may be installed by the vibration isolation manufacturer.

H. Defective Installations: The Contractor shall correct, at no additional cost to the Owner, all installations, which are deemed defective in workmanship or materials by the Architect or Consultant.

I. Suspend the vibration isolators supporting piping and equipment from structural members.

J. Provide a minimum of 1-inch clearance between the building structure and vibration isolated supports, ducts, pipes, and equipment.

K. Provide 2-inch minimum clearance under vibration-isolated equipment and the top of the housekeeping pad and/or steel equipment support frames.

L. Subsequent to proper alignment, fasten all vibration isolators to the structure. Use bolts where holes are provided in the mounting flange; otherwise, adhere using structural adhesive. Where mounting flanges are steel, use neoprene
grommets and washers to isolate anchor bolts from base plates.

M. Do not use vibration isolation components to straighten or connect misaligned sections of piping or ductwork.

N. Any bracing or supports for mechanical ductwork, piping and equipment shall not bridge or reduce the effectiveness of vibration isolators.

O. Install slack cables at all vibration isolated equipment that is to be restrained using steel braided cables appropriately sized and attached for the loads.

P. Level vibration isolated equipment under rated design operating conditions while maintaining the isolation criteria. Isolators shall be plumb and aligned during operation.

3.05 Equipment Isolators

A. Structural Frames: Machine to be isolated shall be supported by a structural steel frame, Type RS, or Type IRSF frames as described herein.

B. Brackets: Brackets shall be provided as required to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket shall be submitted by the isolator manufacturer.

C. Clearance: Operating clearance between the bracket and the pad or floor shall be 3/8” 1/16”. The minimum operating clearance between the frame and the housekeeping pad or floor shall be 1”, for rigid steel and 2” for concrete inertia base.

D. Shims: Frame shall be placed in position and the brackets supported temporarily by 3/8” shims prior to the installation of the machine or isolators.

E. Support: Isolators shall be installed without raising the machine and frame assembly.

F. Adjustment: After the entire system installation is completed and under full operation load, the isolator shall be adjusted so that the load is transferred from the shims to the isolator. When all isolators are properly adjusted, the shims should be barely free and shall be removed. Thereafter, the shims should be used as a gauge to check that the 3/8” clearance is maintained so that the system will remain free of stress.

3.06 Installation Requirements, Motion Restraints

A. Inspection: All installations shall be inspected and approved by a Civil or Structural Engineer licensed in the Project jurisdiction for adequate motion restraint and to assure that such does not short-circuit vibration isolators during normal operation. Adjustments, as reasonably required, shall be made by the Contractor at no expense to the Owner. Such inspector shall be provided by the Contractor, and the Engineers shall certify the installation in writing.

3.07 Piping and Duct Resilient Support and Suspension

A. Applies: Pipes included under this Section of the Specifications are heating water, chilled and all domestic and industrial water piping including that connected to vibrating equipment.

B. Does Not Apply: Piping not included is piping not listed above and fire standpipe and sprinkler piping.

C.Extent: Pipes and ducts connected to vibrating equipment shall be resiliently supported or suspended for a distance of 30 feet from such equipment. Refer to Part 2 for products. All connections to such equipment include flexible connections specified elsewhere in this Section in minimum lengths conforming to the recommendations in Table 35, Chapter 42, ASHRAE 1991 HVAC Applications.

D. Spring Hangers:
1. Suspension Isolators shall be installed with the isolator hanger box as close as possible to the structure. Such isolators shall be suspended from substantial structural members, not from slab diaphragms unless specifically approved.

2. Hanger rods shall be aligned to clear the hanger box.

E. Vibration isolate all pipes in sound-rated construction except vents, gas and sprinkler lines. Do not allow piping, plumbing or vent stacks to contact gypsum board.

F. Do not suspend plumbing or piping from ducts, conduits or related supports.

G. Isolate pipes 3-inch diameter and greater attached to the inlet and discharge of prime movers and pressure-reducing valves using Type MS, HS or P isolators selected to provide 1-inch static deflection for the first six points of support.

H. Isolate the remainder of pipes 3-inch diameter and greater using Type HN or BR isolators selected to provide a static deflection of 0.2 inches. Use Type NSP resilient pads under pipe elbows supported from the floor.

I. Pipes less than 3-inches diameter attached to prime movers and pressure-reducing valves are to be isolated for a minimum of 25-feet from the inlet and discharge. Use Type HN isolators for vibration isolation hangers and Type MN for floor-supported mounts selected to provide a static deflection of 0.2-inches. Use Type NSP resilient pads under pipe elbows supported from the floor. Where these pipes have 3/4-inch-thick or greater resilient thermal insulation between the pipe and the pipe hanger, vibration isolators are not required.

3.08 Installation Requirements, Flexible Duct Connectors

A. Alignment: Align sheet metal duct with fan or fan casing opening in all three dimensions prior to installation of flexible connection, so that duct opening nearly coincides and are almost equally spaced from one another all around. Do not install flexible connection until above requirements are met.

B. Free motion: Fans or fan casings and ducts shall be able to move 1” in any direction relative to each other without short-circuiting metal to metal or stretching taut the flexible connection.

3.09 Installation Requirements, Flexible Piping Connections

A. Application: Flexible piping connections shall be installed within 10 feet of all vibrating equipment, or prior to penetration of the building, whichever is shorter, on all piping connected to such equipment.

B. Placement: Flexible piping connections shall be located such that their length is at right angles to the principal direction of movement and thus such that the movement of the equipment does not alternately place the connection into tension and compression.

C. Length: Flexible piping connectors shall be installed in accordance with the manufacturer's recommended procedures and in lengths complying with Table 28, Chapter 52, ASHRAE 1995 Applications Handbook.

D. Braided metal hose: Where permitted as a substitution, shall be installed in pairs, one in the vertical plane and one in the horizontal plane at each location that a single flexible pipe is required in this section.

3.10 Installation Requirements, Resilient Penetrations

A. Application: Penetrations included in this Section of the Specifications include all piping and ducts connected to vibrating equipment within 30 feet of such equipment.

B. Alternate A for round or rectangular penetrations:

1. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each
penetrating element. Provide lintels above, relief structure below and vertical framing between and to
the sides, as required. Provide the above, escutcheon plates and such related construction as is
necessary to make the penetrated structure as solid and massive near the penetrations as the
surrounding construction.

2. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery,
using grout, dry packing, plaster or drywall compound full depth and all around - but only to a maximum
width of 2” - or the requirements of the above paragraph shall not have been satisfied.

3. Pack annular opening with glass fiber between metal sleeve and penetrating element full depth, all
around to a firm degree of compaction. Leave a 2” deep annular opening free at each end of the metal
sleeve; fill this fully with sealant.

C. Alternate B for round penetrations: Observe requirements above, except that use of sealant at sleeve ends is not
required. In lieu of sealant, clamp factory-fabricated sleeve assemblies specified in Part 2 tightly around penetrating
elements, using built-in or field-supplied clamping devices. Apply clamping of sleeves to penetrating services before
sealing of sleeves to penetrated constructions. Refer to manufacturer’s instructions for installation of fire-rated rubber
link systems.

3.11 Mechanical Room/Plenum Requirements

A. Airtight Enclosure: All mechanical rooms, plenums, duct shafts and drywall duct enclosures shall be constructed airtight.
This means that every precaution shall be taken to maintain construction completely airtight around a room so
designated. Construction joints, duct penetrations, electrical boxes, frames, supports, cabinets, doors, access panels,
fixtures, etc., all shall be built or installed in such a manner as to prevent sound transmission through any construction
enclosing a room horizontally or vertically. Appropriate lintels, frames, blocking, escutcheons, grouting, gaskets,
packing, caulking, taping, filling, etc., all shall be employed to prevent sound transmission. Refer to requirements of this
Section for Resilient Penetrations.

B. Discrepancies: All work under this section is to comply with the above. Mechanical Contractor to report to architect any
construction conditions which arise which might compromise compliance with this requirement.

3.12 Required HVAC Ambient Noise Criteria

A. Criteria: The ambient noise levels resulting from HVAC equipment shall not exceed the noise criterion (NC levels)
scheduled below.

B. Contract Documents: The noise criterion scheduled herein have been utilized to determine the sizing of the sound traps
and amount of acoustical lining of ductwork required to meet this criteria.

C. Field Design: Where field alterations are made to the design, main duct and branch duct velocities shall be sufficient to
provide noise attenuation to the noise criteria scheduled herein.
### NOISE CRITERIA

<table>
<thead>
<tr>
<th>AREA</th>
<th>NC CRITERION</th>
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</thead>
<tbody>
<tr>
<td>Large Classrooms, Conference Rooms, Reading Rooms, Study Rooms, Dean &amp; President Offices, Control Booth, Edit Bay</td>
<td>NC-30</td>
</tr>
<tr>
<td>Private Offices, Teaching Labs, Library Stacks, Exhibit Space, Computer Room, Student production</td>
<td>NC-35</td>
</tr>
<tr>
<td>Open Plan Offices, Atrium, Hallways</td>
<td>NC-40</td>
</tr>
<tr>
<td>Storage Rooms, Restrooms</td>
<td>NC 45 to 50</td>
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END OF SECTION
SECTION 15250

INSULATION

PART 1 – GENERAL

1.01 Description

A. Provide complete systems of insulation for piping, ducts, boiler stacks and breeching, and mechanical equipment as specified.

B. Related work specified elsewhere: This section does not include acoustic or thermal duct liner where indicated on the drawings to be applied to the interior side of ductwork or plenums. See SECTION 15880, "DUCTWORK".

C. The intent of these Specifications is that all hot and chilled equipment, piping and other items noted be insulated. The Contractor shall carefully advise himself of the extent of all the factory insulated packaged equipment where piping and miscellaneous parts will be furnished without insulation. Provide insulation as required for all packaged equipment requiring insulation, whether furnished with equipment or not.

D. Piping:

1. From 105 degrees F to 140 degrees F: insulate piping and fittings except flanges, unions, and valves.

2. Above 140 degrees F: insulate piping and fittings including flanges, unions, and valves, except stems and operators.

3. Below 60 degrees F: insulate chilled piping, including refrigeration lines, fittings, flanges, unions, and valves, except stems and operators. Insulate domestic and industrial cold water piping runouts in furred walls, and condensate drain lines to prevent condensation.

E. Ducts, Plenums, and Casings:

1. Insulate heating, and air conditioning supply ducts, from the outside air intake to the room outlets. Insulate flexible runouts, plenums, casings, and air handlers. Install rigid insulation on exposed ducts in interior and outside locations. Use flexible blanket insulation on concealed interior ducts and on exposed round or oval ducts. Insulation shall be continuous through walls and floors except at fire dampers. Insulate return air duct above all ceilings and within shafts.

F. Non-insulated Piping:

1. Condenser water, except as noted otherwise.

2. Vent, overflow, drain, and relief; except where noted otherwise.

G. Non-Insulated Ductwork, Casings, Plenums, and Housings:

1. Where acoustic or thermal duct liner is indicated on the drawings.

2. Return Air Ductwork:
   a. Exposed in air-conditioned spaces.
   b. Above suspended ceiling in air-conditioned spaces.
   c. In duct shafts.
3. Exhaust Ductwork.

H. Non-insulated Equipment:
1. Heating Water expansion tanks.
2. Exhaust fans and fans handling unconditioned air.

I. Definitions:
1. Finished Spaces: Habitation or occupancy spaces where surfaces are plastered, panelled, or otherwise treated to provide a pleasing appearance.
2. Unfinished Spaces: Storage or work areas where appearance is not a factor; unexcavated spaces, crawl spaces, etc.
3. Concealed Spaces: Spaces between a ceiling and floor construction above; between double walls or furred-in areas; pipe and duct shafts, etc.
4. Exposed: Open to view inside the building (including interstitial spaces). For example, pipe run through a room, and not covered by other construction, is exposed.
5. Outside or exterior: Open to view beyond the exterior side of walls; above the roof; unexcavated or crawl spaces, above or beneath pier floors; in tunnels or exposed on all sides in trenches connected or not connected to an exterior portion of a building.

1.02 Quality Assurance
A. Reference Standards:
   a. B 209 Aluminum and Aluminum-Alloy Sheet and Plate.
   d. C 533 Calcium Silicate Block and Pipe Thermal Insulation.
   e. C 547 Mineral Fiber Preformed Pipe Insulation.
   f. C 553 Mineral Fiber Blanket and Felt Insulation (Industrial Type).
   g. C 612 Mineral Fiber Block and Board Thermal Insulation.
2. CCR California Code of Regulations, Title 24
   a. Part 6, California Energy Code.
   b. Part 4, California Mechanical Code (CMC).
3. Federal Specifications (Fed. Spec.):
   a. L-P-535E Plastic Sheet (Sheeting): Plastic Strip: Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid.
   b. L-T-80B Tape, Pressure-Sensitive Adhesive (Aluminum-Backed).
c. HH-B-100B Barrier Material Vapor (For Pipe, Duct and Equipment Thermal Insulation).

d. HH-I-573B Insulation, Thermal, Flexible Unicellular Sheet and Pipe Covering.


5. UL Underwriters Laboratory, Inc.

1.03 Submittals

   A. Product Data:

      1. Submit manufacturer's data on the following:

         a. Insulation Materials.

         b. Jackets and casings.

         c. Adhesives.

         d. Fastening Devices.

         e. Vapor Barriers.

         f. Material Safety Data Sheets (MSDS) shall be submitted for all insulation materials including adhesives, cements and finishing materials.

         g. Proof of California Quality Standards Certification.

PART 2 – PRODUCTS

2.01 Materials

   A. Manufacturer's Stamp or Label: Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use must have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material. Insulation packages and containers shall be marked "asbestos-free."

   B. All insulation materials subject to regulation under CCR Title 24, Part 6, shall meet the requirements of Section 123 and 124, and Table 1-G, and shall be so certified. Submit proof of certification.

   C. Fire Resistance: Insulation, adhesives, vapor-barrier materials, and other accessories, except as specified herein, shall be noncombustible. Materials shall not have a flame-spread rating more than 25 and a smoke-developed rating not more than 50 in accordance with UBC Standard 42-1, except for flexible unicellular insulation which, in thickness greater than 1/2-inch, may have a smoke-developed rating not to exceed 100.

   D. Materials Tests: Test factory-applied materials assembled. Field-applied materials may be tested individually. UL label, or satisfactory certified test report from an approved testing laboratory, will be required to show that fire hazard ratings for materials proposed for use do not exceed those specified. Flame-proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.

   E. Piping Insulation:

      1. Exterior surface of insulation shall be cleanable, grease resistant, nonflaking and nonpeeling. Pipe insulation shall conform with the referenced publications and the specified temperature ranges and
densities in pounds per cubic foot (pcf). Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of the same thickness and conductivity as used on adjacent piping.

2. **Mineral Fiber**: ASTM C 547, for temperature range of 105 to 850 degrees F., preformed, jacketed with double adhesive self-sealing lap. Owens-Corning ASJ/SSL-II, Certain-Teed, or equal.

3. **Fiberglass Insulation with vapour barrier**: Owens-corning, Certain Teed, or equal, for temperature range from -40 degrees to +60 degrees F.
   a. Use for refrigeration suction piping and elsewhere where specified.
   b. Minimum Density: 5.5 lbs./cu.ft.
   c. Thermal Conductivity: 0.28 K factor at 75 degree F.
   d. Rubatex, Armaflex, or equal.

F. **Ductwork, casings, housings, plenums, breeching and equipment insulation**: Shall conform with the referenced publications. Temperature ranges and densities in pcf shall be as specified.

1. **Fiberglass Duct Wrap**: Fiberglass blanket with foil reinforced kraft paper vapor barrier; 250 degrees F. maximum; 0.27 Btu/in/hr/sq.ft./degree F. at 75 degree F. mean temperature. Owens Corning Type ASW with FRK facing; Certain-Teed or equal.

2. **Flexible Mineral-Fiber Blanket**: ASTM C 553, Type I (flexible resilient), up to 1000 degrees F, 0.28 Btu/in/hr/sq.ft./degree F. at 100 degree F. mean temperature. Owens Corning TIW Type I; Certain-Teed or equal.

3. **Rigid Mineral-Fiber**: ASTM C 612, board type, to 450 degrees F, 3 pcf, foil reinforced kraft facing or all-service jacket facing. Owens Corning Type 703 with FRK jacket; Certain-Teed or equal.

4. **Mineral Fiber Block**: ASTM C 612, semi rigid, bonded fiberglass fibers, 850 degrees F. maximum; 3.0 pcf; 0.23 Btu/in/hr/sq.ft./degree F. at 75 degree F. mean temperature. Owens Corning Insul-Quick; Certain-Teed or equal.

G. **Insulation Jackets**:

1. **Vapor-Barrier Material**: HH-B-100, Type I. Material shall be resistant to flame and moisture penetration and not support mold growth. Provide foil reinforced kraft facing in concealed locations. Provide vapor-barrier material all service jacket on insulation in exposed locations with a white surface suitable for painting without sizing. Lamtec 70JASJ.

2. **Aluminum Jackets**: ASTM B 209, Temper H14, 0.016 inch thick, smooth. Do not use on calcium silicate surfaces or surfaces above 200 degrees F operating temperature. Pabco-Childers Lock-On or equal.

3. **Weatherproof**: Aluminum jacket, ASTM B 209, minimum 0.016-inch thick, moisture barrier adhered to inside face. Pabco-Childers Lock-On or equal.

4. **PVC Jackets**: (limited to indoor piping only). Fed. Spec. L-P-535, Composition A, Type II, Grade GU. One-piece premolded plastic covers for fittings, flanges, and valves. Zeston, Speedline, or equal.

H. **Removable/Reuseable Insulation**: Shall be one or two piece design with silicone coated fiberglass cloth liners, minimum of 1/2-inch thick fiberglass insulation, and a weather barrier of teflon coated fiberglass. Sewing thread shall be teflon coated fiberglass. Quilting pins shall be used to prevent shifting of insulation. Covers shall have rain flaps and straps with stainless steel double buckles or Velcro fasteners. Johnson Energy Products, Accessible Products Co., or equal.

I. **Adhesives, Sealants, and Compounds**: Shall be compatible with materials to which applied and suitable for the service.
1. Vaporaseal Adhesive: Spark-fas 85-20 or equal, U.L. Label
2. Lagging Adhesive: Fosters 30-36 or equal, U.L. Label
3. Insulation Cement: ASTM C 195, mineral fiber, thermal conductivity 0.85 max. at 200 degrees F mean when tested per ASTM C 177. Fibrex, Pabco, or equal.
5. Adhesive for Flexible Unicellular insulation: Rubatex R-373, Armstrong 520 or equal.

J. Accessories:
2. Insulation Bands: 3/4-inch wide; 0.018-inch stainless-steel or 0.020-inch aluminum. Band-It, Houdaille, or equal.
3. Bands for Metal Jackets: 3/8-inch minimum width; 0.018-inch stainless-steel or 0.020-inch aluminum. Pabco-Childers or equal.
4. Wire: Minimum 16-gauge stainless steel or copper-clad annealed steel wire.
5. Anchor Pins: Anchor pins, clips and speed washers; AGM Industries, Accessible Products, or equal.
6. Glass Cloth and Tape: Childers No. 10, J.P. Stevens Glass-Tex, open weave, white color cloth; Childers VI-CRYL CP 10, Fosters Aquafas, Eco-Mastic 55-50, or equal, weatherproof Mastic.
7. Aluminum-Foil-Backed Pressure-Sensitive Adhesive Tape: Fed. Spec. L-T-80, 50 degrees F max. and limited to use on insulation with factory-applied jacket with aluminum foil facing. Venture Tape, Compac Corp. or equal.
8. Vapor-Barrier Material Tape: Fed. Spec. HH-B-100, Type I, pressure-sensitive adhesive backed, Lamtec 70JASJ, Ideal Tape Co. or equal.

PART 3 – EXECUTION
3.01 Installation/Application/Erector
A. General:
1. During the installation and when putting insulated systems into service, the contractor shall observe all instructions, recommendations, and Cautions issued or published by the insulation materials manufacturers.
2. Preparation: Do not apply insulation until surfaces to be covered have been leak tested, have had rust and scale removed, and have been cleaned, dried, and inspected.
3. Application: Insulation shall be clean and dry when installed and kept dry during finish application. Wetted insulation will not be approved for installation. Install materials neatly with smooth and even surfaces with jackets drawn tight and smoothly cemented down on longitudinal and end laps. Scrap pieces shall not be used where a full-length section will fit. All surface finishes shall be extended to protect all surfaces, ends, and raw edges of insulation. Coatings and adhesives shall be applied at the manufacturer’s recommended coverage per gallon.
4. Name Plates and Access Plates: Do not insulate name plates or ASME labels. Bevel insulation around name plates and ASME stamps.
5. Calcium Silicate: Do not install on aluminum surfaces.
B. Piping:

1. Provide insulation of thickness specified for the applicable temperature and service in accordance with California Energy Code. Installed insulation thickness shall exceed required code thickness by 10% (minimum).

2. Pipe Insulation (Except Flexible Unicellular): Install with joints tightly butted. Overlap longitudinal jacket laps not less than 1-1/2 inches. Wrap butt joints with 3-inch wide strips of the same material as jacket. Cement jacket laps and butt strips with adhesive or bedding compound and joint sealer and additionally secure with flared staples on 4-inch centers outside clinched without complete penetration of insulation. A factory-applied self-sealing system may be used without staples unless fishmouths develop. Where vapor barrier jacket on cold or chilled piping is stapled or punctured, the jacket shall be brush-coated with vapor-barrier coating. Adhesive is not required on hot piping jackets when staples are used.


4. Flanges, Unions, Valves, and Fittings: Except where Flexible Unicellular is applied, use premolded, precut, or job-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Provide fittings with one-piece insulation covers. When segments of insulation are used, provide elbows with no less than three segments. For other fittings and valves, cut segments to required curvature. Place and join the segments of the insulation with adhesive. After the segments are in place, apply vapor-barrier coating. Cover unions and flanges with removable sections of insulation vapor-barrier-sealed inside and out with adjacent insulation ends neatly finished and vapor-barrier-sealed. Where unions, flanges, and valves are specified not to be insulated, terminate the covering neatly at the ends with insulation cement trowelled on a bevel. Apply a vapor-barrier coating to the beveled ends.

5. Provide Removable/Reuseable type insulation for strainers, expansion joints, fittings, valves, and accessories requiring servicing or inspection; or insulation removable and replaceable without damage, within two-piece, No. 18-gauge aluminum covers fastened with cadmium-plated bolts and nuts. Removeable covers for strainers may be applied to the strainer removal section only.

6. Flexible Unicellular Insulation: Temperature range minus 30 to plus 220 degrees F. Flexible unicellular insulation shall not be used in pipe chases and fire walls, nor penetrate fire walls. Use an adhesive recommended by insulation manufacturer and apply in accordance with manufacturer's published instructions. Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. Vapor seal unicellular insulation to piping in accordance with manufacturer's instructions. Do not apply unicellular insulation in multiple layers.

   a. All flexible connections in chilled water and heating water piping shall be insulated with flexible unicellular insulation.

7. At Pipe Hangers:

   a. Insulation protection saddles and shields are specified in SECTION 15050, "BASIC MECHANICAL MATERIALS AND METHODS". Tape all butt joints where insulation butts against hanger shield. On hot piping, apply 3-inch wide canvas strip dipped in lagging adhesive over butt joints.

   b. Embed no hangers in insulation.

C. Ductwork, Casings, Plenums and Air Highways:

1. Where ducts run in groups too close to be individually insulated and finished, completely fill all spaces between ducts with rigid or flexible insulating material and insulate the group of ducts as one duct.

2. Where ducts cannot be insulated after erection, insulate prior to installation.

3. Access Plates and Doors: On internally insulated ducts, plenums, and casings, continue insulation on
access plates and doors. Bevel insulation around access plates and doors. For externally insulated ducts provide duct access doors as per 15880 Ductwork and terminate the covering neatly at the ends around the access door using channels and vapor barrier taping.

4. Rigid Insulation: Use in Mechanical Rooms and exposed locations and under air highway access floor panels (see also 15880 for acoustical ductliner). Secure rigid insulation by impaling over pins or anchors located not more than 3 inches from edge of boards and spaced on not more than 18-inch centers; secure with washers and clips. Spot-weld anchor pins or attach with an approved waterproof adhesive especially designed for use on metal surfaces. Each pin or anchor shall be capable of supporting a 20-pound load. Provuding ends of clips shall be cut off flush after clips are secured and sealed with aluminum backed pressure sensitive tape and coated with silicone adhesive. Apply insulation with joints tightly butted. Where vapor barrier is specified, all joints, breaks, punctures, and voids shall be filled with vapor barrier coating compound and covered with vapor seal material identical to that surrounding.

5. Flexible Duct Wrap Insulation: Use in all concealed locations. Apply over clean, dry sheet metal ductwork that has been sealed air-tight at all seams and joints. Install to allow maximum fullness at corners (avoid excessive compression). Minimum thickness at corners is 1-inch. Butt insulation tightly at joints; vapor barrier facing shall be overlapped a minimum of 2-inches. Staple all seams approximately 6-inches on center with outward clinching staples, then seal with a foil vapor barrier tape, or vapor barrier mastic. When ducts are over 24-inches in width, the duct wrap shall be additionally secured to the bottom of rectangular ducts with mechanical fasteners spaced on 18-inch centers, maximum, to prevent sagging of insulation. Seal penetration of facing to provide a vapor tight system.

6. Insulation Thickness:
   b. Fibrous glass board, 3-pound density, foil-scrim-kraft facing, vaporsealed. For ductwork plenums and casings exposed to view:
      (1) Match sizes of reinforcing and connecting angles. Verify sizes of angles in field: Minimum 1-inch thick.
      (2) In General:
         a) To 42-Inches Wide: 1-inch.
         b) 43-Inches Wide and Over: 1-1/2-inches.

D. Equipment:

1. Insulate heating equipment and accessories above 105 degrees F. Insulate cooling and refrigeration equipment, and accessories and cold surfaces with operating temperatures below 60 degrees F.

2. Equipment Insulation:
   a. Above 850-degrees F.: Calcium-silicate blocks, secured with wire or bands. Finish with insulating cement and a 6-ounce canvas jacket sized with Fosters 30-36 or Arabol.
   b. Less than 850-degrees F.: Fiberglass board applied in accordance with manufacturer's instructions. All insulation edges and butt joints shall be sealed with pressure-sensitive joint sealing tape to match the jacket. Use 3-inch wide tape on flat surfaces, or where edges are shiplapped and stapled. 5-inch wide tape may be used in lieu of shiplapping.
   c. Apply equipment insulation to fit as closely as possible to equipment. Insulation shall be grooved or scored where necessary to fit the contours of equipment. Stagger end joints where possible. Secure the insulation with 16-gage stainless steel or copper-clad wire or...
with 3/4-inch wide 0.018-inch stainless steel, or 0.020-inch aluminum bands spaced on 12-inch centers. Bevel the edges of the insulation for cylindrical surfaces to provide tight joints. Fill joints, seams, chipped edges, or depressions with bedding compound to form a smooth surface. Seal joints with insulating cement and cover insulation with a coat of finishing cement. Insulation on equipment that must be opened periodically for inspection, cleaning, and repair shall be constructed so insulation can be removed and replaced without damage.

3. Equipment Insulation Thicknesses:
   b. Flexible unicellular: 3/4-inch.
   c. The specified insulation thicknesses for equipment shall be increased where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface.

E. Insulation Finish:
   1. Provide Fed. Spec. HH-B-l00, Type I, vapor barrier covering for piping and ducts. Vapor barrier surfaces shall be suitable for painting.
   2. Hot piping, Ducts and Equipment:
      a. All hot-pipe and duct insulation exposed within the building shall be finished with a PVC jacket.
   3. Cold Piping, Ducts and Equipment:
      a. Fittings, flanges, elbows, and irregular surfaces shall be insulated the same as hot piping with special care taken to seal all joints including butts to ensure a continuous vapor barrier.
      b. Insulated piping exposed to weather shall be provided with weatherproof aluminum jacket; seamed to insulation with aluminum or stainless steel bands, Pabco-Childers Lock-On, Insulcoastic, or equal.
   4. Insulated Ducts Exposed to Weather (where internal lining is not shown) provide:
      a. Seal vapor barrier on insulation board.
      b. Apply mastic finish over insulation finish. Apply in two coats, the first coat being a tack coat applied at a rate of two gallons per 100 sq.ft. While still wet a layer of #10 open weave glass cloth membrane shall be embedded with all fabric seams overlapped a minimum of 2". A finish coat at a coverage of four gallons per 100 sq.ft. shall be applied, fully covering the cloth membrane and applied so that the minimum dry film thickness is 1/16" (0.063") There shall be no voids or holidays and the mastic shall be trowelled, sprayed or wet-brushed to a smooth even finish.
   5. Provide Aluminum jacket at all insulated piping located 8’ or under in mechanical rooms. Provide PVC jacket at all other insulated piping in mechanical room and indoor piping exposed to view.

END OF SECTION
SECTION 15300

FIRE PROTECTION

PART 1 – GENERAL

1.01 Description of Work

A. Provide complete and operative Automatic Sprinkler System as shown and specified providing full coverage including connection to existing mains and new piping and new sprinklers to suit partitioning arrangements.

B. System complete with equipment, piping and related appurtenances. In addition to items specifically indicated, provide miscellaneous items required to result in complete and operable system.

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

1. Section 09900 For Painting of Exposed Piping and Hangers.
2. Section 15010 Mechanical General Requirements.
3. Section 15050 Basic Mechanical Materials and Methods.
4. Section 15060 Pipe and Pipe Fittings.
5. Section 15090 Supports and Anchors.
6. Section 15100 Valves.
7. Section 15200 Sound Vibration and Seismic Control.

1.02 Quality Assurance

A. Contractor Qualifications:

1. The Contractor shall be a California licensed Contractor with a C-16 license experienced in the installation of automatic sprinkler systems. Provide qualifications with submittal.

2. All drawings shall be stamped and signed by a fire protection engineer who is licensed by the State of California.

3. The Contractor shall have been in the business of designing, installing, testing, and maintaining automatic sprinkler systems for at least 5 years.

B. Design Criteria

1. Remove, relocate and provide new sprinkler heads so that to ensure full coverage for all the remodeled areas of the scope of work, and where required by code.

2. The system shall be hydraulic calculated for 0.2 gpm over the most remote 3,000 sq. ft., which is Ordinary Hazard Group 2.

3. Base the piping system and arrangement of heads upon Architectural and Structural considerations. All pipe sizes and number of heads to be used for each area or room shall conform to the requirements to the California Building Code, State Fire Marshal’s Office, and NFPA.
13, 2010 Edition. Locate piping per architectural drawings where shown.

4. Sprinkler head shall be in pendant position at suspended ceilings and in upright or pendant position at all other locations, as per University Representative’s instruction.

5. Where heads are located at suspended ceiling, spacing shall be as required by NFPA 13, except as follows: In all locations, sprinkler heads shall be equal distance between lights, between wall and lights, between lights and air diffusers, and between wall, lights, and air diffusers. Provide uniform and repetitive pattern for each room. Locate by reflected ceiling plan in Architectural Drawings where shown.

6. Center sprinkler heads in center of ceiling tiles in order to conform to above.

7. It shall be understood that Paragraphs B.4 and B.5 may require more heads than would be required to satisfy the spacing allowed under the Code. Symmetry is required.

8. See architectural reflected ceiling plans, but comply with codes for general design.

9. The maximum floor coverage per sprinkler head shall not exceed 200 sq. ft.


11. The building automatic sprinkler system drains are to be located where noted, and designed to minimize damage to the building and adjacent landscape when testing.

12. Obtain the latest water flow test data from authorities having jurisdiction to determine volume and pressure available from incoming water supply.

13. The type, size, arrangement configuration and hydraulic calculations shall be approved by the State Fire Marshal

C. Requirements of Regulatory Agencies:


2. NFPA - National Fire Protection Association

3. UBC – California Building Code
   a. Standard No. 9-1.


1.03 Submittals

A. Shop Drawings and Product Data

1. Prior to obtaining approvals noted below, submit reflected ceiling scale Drawings for University’s Representative’s review showing sprinkler heads in relation to lights, air diffusers, ceiling joints and tiles, speaker, TV outlets, and any other ceiling outlets or obstructions, to the University Representative for review. Complete Shop Drawings shall incorporate revisions required by the University Representative’s review and shall then be submitted to the Fire Marshal.
2. Shop drawings shall show the location of all sprinkler heads, piping, bracing, hangers and anchors and shall included all necessary working drawings showing complete details of the piping within the building.

3. All drawings and calculations prepared by the Contractor shall be stamped by a professional engineer licensed in the State of California. Drawings and calculations submitted for review shall have been reviewed and approved by the Fire Marshall prior to commencement of any Work on the sprinkler system. Submit proof of these approvals.

4. Provide all necessary information to ceiling suspension work, to provide coordinated submittals.

5. Before receiving final acceptance of job, furnish written statement to the effect that the Work has been completed and tested in accordance with the accepted Drawings and Specifications.

6. Provide details and sections as required to clearly define design. Include a materials list describing proposed materials.

7. All shop drawings shall comply with Section 15.

B. Product data shall include, but not be limited to the following:

1. Pipes and fittings.
2. Pipe hangers and sway braces.
3. Drains, test connections, and accessories.

C. Maintenance Material (Spare Parts)

1. Furnish a sprinkler cabinet containing the minimum number of extra heads and a wrench in accordance with the requirements of NFPA 13. Coordinate with the Campus Fire Division for the location of the cabinet housing the spare sprinkler heads and wrench.

D. Operating Instructions

1. Provide, next to sprinkler riser, a printed sheet protected by transparent plastic cover, with brief instructions regarding all necessary aspects of sprinkler controls and emergency procedures.

E. Record Drawings

1. Refer to Section 01780 Close Out Submittals.
2. During progress of Work, maintain accurate record of all changes made.

F. Related Sections

1. Section 07840 Firestopping.

PART 2 – PRODUCTS

2.01 Materials

A. Pipe

1. Above Ground: Schedule 40 black steel, threaded, rolled or cut grooved or welded, Type F, Grade A, ASTM A53; black steel welded and seamless steel pipe for fire protection, Type F, ASTM A795; electric resistance welded steel pipe, Grade A, ASTM A135.
2. Threaded or cut grooved lightwall pipe and plastic pipe are not acceptable.

B. Fire Sprinklers
   1. Gem, Viking, Automatic Sprinkler Co. or equal.
   2. Suspended ceilings: Quick response, flush type, concealed with matte white cover.
   3. Window Sprinklers: Central Model WS
   4. Exposed ceilings and plenum spaces: Pendant, upright standard or side wall sprinklers, rough brass or equal, with plain bronze finish and white enamel escutcheons. Where sprinklers are exposed outside the conditioned building envelope, provide corrosion resistant wax-coated brass with stainless steel escutcheons.
   5. Provide sprinklers with appropriate temperature ratings per NFPA-13.
   6. Where sprinklers are subject to mechanical abuse, impact or less than 7 feet above finished floor, provide approved guards.
   7. Provide steel cabinet with additional sprinklers in amounts of 5 percent to total of each type installed; and 1 wrench for each sprinkler type. Cabinet is to be located in the general area of the main building riser with the exact location to be approved by the University Fire Division prior to placement.

C. Pipe Escutcheons: Stamped steel, chrome plated, hinged, with set screw, Grinnel Fig. 13, or equal. Stainless steel escutcheons where exposed outside the building's conditioned envelope.

D. Identification Signs: Enamelled metal of the standard design adopted by the Automatic Sprinkler Industry.

2.02 Pipe Supporting Devices
   A. U.L. listed, Grinnell, Tolco, or equal.
   B. Rods: Shall be sized in accordance with the direction of the manufacturer and the NFPA, but not less than 3/8-inch diameter.
   C. All pipe supporting devices, rods, accessories, etc., shall be galvanized after fabrication to prevent rusting and corrosion. At completion of work, any pipe supporting apparatus or accessory exhibiting rust or corrosion will not be accepted.

2.03 Miscellaneous Steel, Bolts, Nuts, and Washers
   A. Miscellaneous steel angles, channels, brackets, rods, clamps, etc., shall be of new materials conforming to ASTM A36. All bolts and nuts, except as otherwise specified shall conform to ASTM. Bolts shall have heavy hexagon heads, and nuts shall be of the hexagon heavy series. All bolts, washers, nuts, anchor bolts, screws, and other hardware, unless otherwise specified, shall be galvanized, and all galvanized nuts shall have a free running fit.

PART 3 – EXECUTION

3.01 Fabrication Installation
   A. In accordance with requirements of Section 15010 Basic Mechanical Requirements, and Section 15060 Pipe and Pipe Fittings, and Standards of NFPA.
   B. Special Sprinkler Coverage:
1. Window Sprinklers, Area Of Use: Provide Central Sprinkler Co. Model WS “Specific Application Window Sprinklers” on both sides of the windows, where noted on the drawings.

2. Distance between Window Sprinkler shall be in accordance with the Manufacturer's installation requirements and window construction.

3. Recommended Hydraulic Requirements: The Authority Having Jurisdiction should be consulted to determine the hydraulic requirements for each installation. Interior Protection Sprinklered Building - Identify, which compartmented area, has the most hydraulically demanding window sprinklers. Calculate all of the sprinklers within a compartmented area or the number of window sprinklers required to cover a combined linear length of glass equal to 1.2 x the square root of the system area of operation, whichever is greater. For example if the building design area is 1500 ft² then 1.2 x (1500 ft²) 1/2 = 46.5 linear feet of glass. Add the window sprinkler demand to the most demanding hydraulic design area. Interior Protection Non-Sprinklered - Calculate all the sprinklers on the most demanding side of the glazing assembly within the enclosure. Exterior Exposure Protection - Calculate all sprinklers controlled by the deluge valve using the design requirements of NFPA. Duration Of Water Supply: The duration of the water supply must comply with the requirements of NFPA. In the event the window sprinklers are being used to provide the equivalency of a fire rating, the water supply must be capable of supplying water for the required rating period.

4. Minimum Flow Per Sprinkler: 20 GPM for sprinkler spacing of 6 to 8 ft. or 15 GPM for sprinkler spacing less than 6 ft., coordinate with window type per sprinkler manufacturer's guide lines

5. Maximum Pressure Per Sprinkler: Horizontal Sidewall = 70* psi, Vertical Sidewall = 175 psi.

C. *The 70 psi is only for cold solder purposes. If there is a baffle or mullion of sufficient depth to act as a baffle, separating the sprinklers, the maximum pressure is 175 psi.

1. Provide a separate zone valve for the window sprinkler system.

3.02 General Requirements for Piping

A. Whenever changes in sizes of pipe occur, make the change with reducing fittings as the use of bushings will not be permitted.

B. Support and brace all existing and new piping from the building structure by means of hangers, inserts and other supports in accordance with the requirements of UBC Standard 9-1, California Building Code Chapter 16 and SECTION 210548: "NOISE, VIBRATION, AND SEISMIC CONTROL". Horizontal and vertical seismic design forces shall be calculated in accordance with ASCE 7-05, Chapter 13, using a Component Importance Factor (I₀) equal to 1.5, a Component Amplification Factor (a₀) of 2.5, and a Component Response Modification Factor (R₀) of 9.0 for welded and brazed pipe joints and 4.5 for threaded or grooved joints. However, in no case shall the horizontal force factor be less than 50% of the weight of the piping filled with water.

C. Sprinkler auxiliary drain valves, where required by NFPA 13, with enamel sign indicating their purpose and use.

D. Conceal all piping within the building construction except in spaces with no ceiling.

E. Install all piping to maintain required headroom and to not interfere with operation or maintenance of equipment.

F. Install systems to provide for complete drainage and testing.

G. Provide systems with identification signs specified or required by code.

H. Locate extra sprinklers and sprinkler wrench cabinets as directed.

I. Air test systems upon completion prior to hydrostatic test.
J. Exact head location subject to acceptance of University's Representative; provide extra heads if required to comply with above.

K. Coordinate Work with other crafts. Where conflicts occur, relocated sprinkler piping.

3.03 Inspection

A. After completion of the fire protection installation and at the start of the guarantee period, execute the National Automatic Sprinkler and Fire Control Association, Inc. standard form of Inspection Agreement, at no increase in Contract Sum, calling for 4 inspections of the sprinkler system during the guarantee year.

B. Fill out Inspection Agreement in triplicate after each inspection and send copies to the University's Representative and the Campus Fire Division.

3.04 Filed Quality Controls

A. In accordance with the requirements of Section 15990 Tests and Balancing, and as follows:

1. Automatic sprinkler piping in accordance with NFPA Standards: Upon completion and prior to cover-up of any piping and prior to acceptance of the installation subject the system to a hydrostatic pressure test at 200 psig for 2-hour test. Remove and replace all defects due to materials or workmanship occurring during this test and retest after corrections have been made.

   a. Prior to this test, notify the State Fire Marshal and the University's Representative at least 48 hours in advance. A State Fire Marshal representative must be present during testing.

   b. Upon completion of inspections and tests, complete and sign a Contractor's Material and Test Certificate by the Contractor and any witnesses to the tests. Submit the original of the completed certificate to the University's Representative prior to acceptance of the system.

3.05 Stenciling and Identification

A. Provide piping identification per Section 15010.

B. All fire sprinkler piping shall be identified in accordance with the California State Fire Marshal's requirements.

3.06 Cleaning

A. The intent of this Specification is that all equipment and materials furnished by this Section shall be completely dust free, clean and rust free and freshly polished when the final acceptance inspection is made.

B. Clean piping of thread cutting oil and other materials that would interfere with adherence of paint material specified in Section 09900.

3.07 Material Handling

A. Receiving and Handing: Refer to Division 1

B. Rubbish Removal: refer to Division 1

3.08 Test and Maintenance

A. All tests described and references in these standards shall be performed by the contractor in the presence of the University Fire Department representative. A minimum of 72 hours notice is required by the Fire Department prior to need. Tests and inspections shall apply to all water-source fire protection systems, including fire hydrants,
sprinklers, standpipes wet or dry or combination, and all underground piping, which supplies these systems and devices.

B. All piping shall be hydrostatic-pressure tested in accordance with these standards, and the following listed codes and standards:


C. Systems shall be hydrostatic-pressure tested with installed drops and heads and prior to installation of ceilings or enclosure of sprinkler piping. Inspection of hangers, sway bracing and arrangement of valves and sprinkler heads will be conducted at the start of hydrostatic test, when pipe is filled with water. Adjustment of drops after installed ceilings will not require additional hydrostatic tests.

3.09 Hydrostatic Test Preparation

A. The following preparations shall be made for hydrostatic testing:

   1. Interior piping shall be filled with water two hours preceding hydrostatic testing.

   2. Piping shall be purged of all air and other gases prior to hydrostatic testing.

   3. All above grade and interior piping, fittings, and supports shall be exposed for inspection and hydrostatic testing.

   4. Test of drainage facilities shall be conducted by opening each drain valve while the system control valves are open to the supply. AU systems will be tested in the presence of the University Fire Division.

   5. Water remaining in normally dry piping shall be evacuated at completion of testing.

   6. Upon satisfactory completion of all testing and inspections, the contractor shall certify to the University Fire Department by submittal of a completed Form 6, “Contractor's Material & Test Certificate for Aboveground Piping” and/or Form 7, “Contractor's Material & Test Certificate for Underground Piping” immediately upon completion of said test and inspections. Any variation in procedure must be approved in writing by the University Fire Division.

   7. Hydraulic nameplate, required sprinkler spares and wrench with box and other control valve signage and miscellaneous required materials shall be provided prior to acceptance of system.

   8. Contractor shall be responsible for coordination of all testing. System shall not be acceptable with uncorrected or unresolved deficiencies. Water damage or associated defects as a result of failure of piping or materials are the responsibility of the Contractor.

3.10 Training

A. Submit a written test schedule to the University's Representative for approval a minimum of 3 weeks prior to proposed training dates.

B. Provide three sessions of 2-hours each of instruction to the Campus Fire Division with regard to proper use and operation of the system. Submit a written course outline and a sample of all manuals to be used 2 weeks prior to the scheduling of the training. Training shall include both classroom and “hands-on” sessions and shall occur after final inspection and testing. Location and timing of the training session is to be arranged with the University's Representative and Fire Division.

C. Two weeks prior to scheduled training dates, furnish the University's Representative with 6 bound copies of complete instructions, including catalog cuts, diagrams, drawings, and other descriptive data covering the proper testing, operation, and maintenance of each type of system installed, and the necessary information for ordering
replacement parts. In addition, post 1 copy of complete instructions at the control panel location.

D. Session shall include detailed training and instructions covering the necessary and recommended testing, operating, and maintenance procedures for each type of system.

E. Session shall include training and instructions covering the emergency operation procedures for each type of system.

END OF SECTION
SECTION 15880

DUCTWORK

PART 1 – GENERAL

1.01 Description of Work

A. Work includes air distribution and collection system including appurtenances.

1.02 Related Work and Requirements

A. Requirements of General Conditions and Division 1 and Section 15010 Mechanical Basic Materials and Methods apply to work of this section.

B. Section 15090 Support and Anchors

C. Section 15200 Noise, Vibration and Seismic Control

D. Section 15250 Insulation

1.03 Quality Assurance

A. Design Criteria: Contribution to noise level not to exceed NC 35 in Offices and NC 45-50 in Laboratories.

B. Flexible Fabric Connector Material and Flexible Duct: Shall meet the requirements of NFPA Standards Nos. 90A and 90B.

C. Flexible Fibrous glass duct liner, complying with NFPA 90A/90B and ASTM C1071.

D. Fire Dampers: Approved and listed by California State Fire Marshal.


F. Combined Fire and Smoke Dampers: Leakage rated per UL 555S and approved by the State Fire Marshal.

G. Referenced Standards:

1. ASC - Adhesive and Seal Council
   a. ASC - 7100C Standard for Adhesives for Duct Liner.

2. CCR - California Code of Regulations.
   a. Title 24, Part 4 California Mechanical Code, Chapter 10, Ducts.

3. SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

H. The VOC content of adhesives and sealants used must be less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1168, AND all sealants used as filters must meet or exceed the requirements of the Bay Area Quality Management District Regulation 8, Rule 51.
1.04 Submittals

A. Submit large-scale drawings in accordance with the requirements of Section 01340 Shop Drawings, Product Data and Samples and as follows:
   1. Large-scale layout drawings of all areas in which it may be necessary to deviate substantially from layout shown. Minor transitions in ductwork, required to avoid local interference with other trades, need not be submitted, as long as the duct area is maintained. Show major relocation of ductwork and major changes prior to ductwork fabrication. Submit changes which include abrupt section changes or nested fittings.

B. Method of attachment of duct hangers to building construction.

C. Product Data: Submit duct material, gauge, type of joints and duct reinforcing for each size range, for joints, method of fabrication and reinforcing. Submit manufacturer’s catalog data sheets for air distribution and other devices.

D. Sample round welded duct fitting.

PART 2 – PRODUCTS

2.01 Materials

A. Sheet Metal:

B. Turbine Fan Exhaust Duct: See Section 15060 Pipe and Pipe Fittings.

C. Duct Hangers:
   1. Band Hangers: Same material as ducts, except that hangers for stainless steel ducts in unfinished spaces may be galvanized steel.
   2. Rod-Type Hangers: Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with 2 removable nuts each end for positioning and locking rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

D. Miscellaneous Fasteners and Upper Hanger Attachments:
   1. Sheet Metal Screws: Same material as duct.
   3. Beam clips: B-Line Fig. B3060 side beam angle clip, Superstrut, Unistrut or equal by.
   4. Beam Clamps: B-Line Fig. B3055, Superstrut, Unistrut or equal by.

E. Flexible Duct Liner: Fibrous glass duct liner, acrylic surface treatment on airside. Manville permacote Linacoustic HP, or equal.

F. Variable air volume boxes: Titus model number DESV, Nailor, Price, or equal with sizes as indicated on drawing schedule. Boxes shall be equipped with single row hot water reheat coils.

2.02 Fabrication and Manufacturers

A. Ducts, plenums, flashings, and other duct appurtenances shall be fabricated of prime galvanized steel and shall
conform to the construction standards of the CMC Chapter 6, Table 6-1 and in accordance with SMACNA pressure classification and seal classes listed for ductwork systems involved.

1. Rectangular ductwork:
   a. ± 2 inches WG Class with Seal Class B: Supply air ductwork downstream of terminal boxes, and non-lab exhaust ductwork.
   b. ± 3 inches WG Class with Seal Class A: Supply air ductwork upstream of terminal boxes, and general lab exhaust ductwork (EFI)

B. Round and flat oval ducts shall be used where shown. Round duct transverse joints shall be beaded sleeve, up to 24 inches diameter and bolted angle rings or “Spiralmate” formed angle and closing ring, secured to duct with screws, for ducts greater than 24 inches.

C. Longitudinal joints shall be Pittsburg lock. No “S” slip or drive slip transverse joints shall be used. Transverse joints shall be pocket locks, Ductmate, Lockformer TDC, or equal.

D. Round Ductwork
   1. For 2 in. w.g. positive and negative.
   2. Factory or shop fabricate interlocking spiral lockseam duct, without external standing rib upstream of volume control boxes, with external rib downstream of boxes and for single branches of return air duct system.
   3. Prefabricated fittings. Site fabricated fittings and saddle taps not permitted.
      a. Same manufacturer as duct.
      b. Continuously welded seams, except downstream of pressure regulating volume control dampers where spot welds on 1 inch centers are allowed.
      c. Die stamped elbows for 8 inches or smaller. Optionally to 12-inches diameter.
      d. Elbows larger than 8 inches.
         (1) 2 gores - less than 35 degrees.
         (2) 3 gores - 36 degrees through 71 degrees.
         (3) 5 gores - over 71 degrees.
      e. "Spin-in" round taps into rectangular ducts to be conical with welded seams.
      f. Tee and cross fittings to have conical branches.
   4. Not acceptable:
      a. Corrugated or flexible metal duct.
      b. Duct or fittings not of quality equal to sample.
      c. "Spin-in" round taps connecting to rectangular ducts except where branch flow is less than 15 percent of flow in rectangular duct.
2.03 Registers and Grills

A. Acceptable Manufacturers:
   1. See equipment schedules on drawings.

B. Grilles and Registers: (See Schedule on Drawings)
   1. Unless otherwise shown or specified, fabricate all grille and register faces and frames of steel or aluminum with a factory-applied finish as follows:
      a. For installation in gypsum board, hard plaster or acoustic plaster ceilings specified to be painted, finish shall be a factory-applied white baked enamel.
      b. For installation in walls, specified to be painted, finish shall be factory applied white baked enamel.
      c. For acoustic tile ceilings, provide factory applied white baked enamel.
   2. Provide frames for each grille and register except as follows:
      a. Grilles and registers installed directly in exposed uninsulated ductwork.
      b. Grilles or registers specifically designed for installation in suspended lay-in tile ceilings or suspended combination lay-in and splined tile grid ceilings.
   3. Supply Grilles except where otherwise scheduled: Provide adjustable, double-deflection type, consisting of a heavy formed face, with rear bars or vanes installed in a No. 20-gauge frame of the same material as the bars or vanes. Install face bars and rear bars or vanes on nominal 0.75-inch centers, individually adjustable and front pivoting to any desired setting.
   4. Exhaust Grilles except where otherwise scheduled: Provide 35-degree or 45-degree fixed single deflection type, consisting of a heavy formed face with horizontal face bars on nominal 0.75-inch centers, installed in a No. 20-gauge frame of the same material as the bars.
   5. Supply Registers: Provide assembly consisting of a register face and damper assembly. Provide register face of the adjustable double deflection type consisting of a heavy formed face, with rear bars or vanes installed in a No. 20-gauge frame, of the same material as the bars or vanes, with the face and rear bars or vanes on nominal 0.75-inch centers; individually adjustable and front pivoting to any desired setting. Provide damper assembly of the opposed multiblade type consisting of a frame, blades and a key operated movement of the locking type, with the operator projecting through the frame. Provide operators, which are removable or permanently secured in place, as directed. Damper may be omitted on individual branches with remote duct damper.
   6. Exhaust Registers: Provide complete assembly consisting of a register face and a damper assembly. Provide register face of 35-degree fixed single deflection type, consisting of a heavy formed face with horizontal face bars on nominal 0.75-inch centers, installed in a frame of the same material as the bars. Provide damper assembly of the opposed multi-blade type consisting of a frame, blades and a key operated movement of the locking type, with the operator projecting through the frame. Provide operators, which are removable or permanently secured in place, as directed. Damper may be omitted on individual branches with remote duct damper.
   7. Frames for Registers and Grilles:
      a. Provide frames fabricated from a minimum of No. 20-gauge extruded aluminum, to match the material and finish of the grille or register face required to be installed in same, with interlocked and mechanically staked corner joints. Furnish frames complete with felt or
sponge rubber gaskets, except when they are used as plaster stops on all four sides.

8. Dampers shall be a minimum of 8 feet upstream of all supply, return and exhaust air terminals where possible.

C. Air Diffusers:

1. Provide diffusers of the circular, square, rectangular, or linear type as scheduled. Do not use neck or duct connection sizes shown to size diffusers.

2. All diffusers shall be of the high-induction type with removable core and trim. Finish same as grilles and registers.

3. Provide all branch ducts to grilles and diffusers complete with volume dampers. Where it is not possible to install volume dampers in ducts, provide grilles and diffusers fitted with opposed blade, key-operated dampers located directly behind the grille or diffuser. Furnish 2 keys for each type of operator.

4. Grilles and diffusers shall be constructed so that the connection to the duct may be taped from the inside when outside is inaccessible.

5. All grilles and diffusers shall be located as shown on drawings.

6. Ceiling plaque registers will not be acceptable as a substitution unless these units are specifically shown or specified.

7. Circular, Square, and Rectangular Diffusers: Provide diffusers complete with a volume control damper except where outlet has an individual remote duct damper, and an adjustable equalizing grid, fabricated of the same material and with the same finish as the diffuser. Diffuser shall have specially designed outer rings or rims with contours of sufficient depth below the ceiling line to minimize smudging.

8. Linear diffusers to have borders of the type scheduled so as to coordinate with architectural finish.

2.04 Ductwork Accessories

A. Dampers:

1. Manual Volume Dampers:

   a. In rectangular branch ducts greater than 9-inches high, provide opposed-blade-type dampers with frames of minimum 16-gauge formed channel, minimum 3-1/2 inches wide with minimum 7/8-inch deep flanges. In rectangular branch ducts 9-inches high or less, provide single-blade dampers with frames of minimum 4-1/2 inch x 12-gauge material or 3-inch wide 22 gauge, with folded angle or flange minimum 2 inch high. Fabricate all damper blades, axles, and frames of the same material as the ductwork in which they are to be installed. Blades: 16-gauge minimum. Blades to close against bead or flange or provided with edge seal. Blades in multiblade dampers: 8-inches wide maximum.

   b. In round or flat oval branches damper blade to be minimum 12 gauge to 18 inches major axis, 10 gauge for larger than 18 inches, frame to be minimum 18 gauge channel, axles to be minimum 2 inches diameter plated steel. Flat oval dampers with major axis greater than 36 to have center mullion. Dampers to be similar to Ruskin CDR25, CD025 or United McGill SOSVH or SRSVH Type 2, or equal.

2. Duct Damper Hardware: Hardware shall be similar to Ventfabrics “Ventlock” or equal as follows:
CSUMB Tanimura & Antle Family Memorial Library  
Third Floor Build Out

a. Uninsulated Duct Dampers above accessible ceilings:

(1) Round ducts: No. 637 elevated dial regulator and No. 607 end bearing.

(2) Rectangular ducts: No. 641 Self-locking Regulator and No. 607 end bearing.

b. Insulated Duct Dampers above accessible ceilings:

(1) Shaft lengths up to 18-inches: No. 637, 3/8-inch Dial Regulator and No. 607 end bearing.

(2) Shaft lengths 19-inches to 48-inches: No. 644 Self-locking Regulator with No. 607 end bearing.

c. Insulated and Uninsulated Duct Dampers above inaccessible ceilings: Install same rod sizes and end bearings for shaft lengths indicated in 2.4.B.1 and 2.4.B.2 above. Install No. 680 miter gear with No. 677 Concealed Damper Regulator. Regulator cover plate shall be natural zinc, prime painted to match ceiling color finish; install flush with ceiling. Submit installation details showing attachment to ceiling support structure. Alternatively, provide Young Regulator Company remote cable control system.

d. U-Bolt Blade Fasteners, if used, shall be: No. 615, spaced at 12-inches on-centers maximum.

e. Provide all couplings, joints, screws, rods, linkages, etc., to complete the installation.

f. On round and flat oval ducts bearings to be mounted on flat surface raised from duct curvature, bracket to be attached with minimum of four screws.

3. Motorized Dampers:

a. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.

b. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.

c. Damper shaft bearings shall be as recommended by manufacturer for application.

d. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.

4. All leakage testing and pressure ratings will be based on AMCA Publication 500.

a. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

5. Control dampers shall be parallel or opposed blade type as scheduled on drawings

B. Turning Vane Assemblies:

1. Fabricate vane assemblies of the same material as the ductwork in which installed. Provide individual vanes of the hollow airfoil type, rigidly connected to vane rails, with the rails screwed into the duct fitting. Vane length not to exceed 36-inches.

2. Turning vanes shall not be used in exhaust ducts.

C. Flexible Connections - Fabric:
1. Heavy glass fabric coated with neoprene weighing a minimum of 30-ounces per square yard.

2. Glass fabric coated with an inorganic elastomeric material, similar to Duro Dyne Corporation "Durolon" or "Thermafab", Advance Elastomeric Systems, Ductmate, or equal.

3. Factory pre-fabricated, pre-assembled flexible fabric connectors with minimum No. 24 USS gauge metal edges similar to "Metal-Fab", as manufactured by Duro Dyne Corporation, or equal.

D. Flexible Duct:

1. Provide flexible duct consisting of flexible vapor barrier jacket, wire reinforced inner core, containing 1-1/2 inch-thick resilient glass fiber insulation faced with reinforced coated glass fabric, conforming to NFPA Standard 90A and CMC Standard 10-1, Class 1. Regenerative noise due to air turbulence within the duct shall not exceed the following sound power levels for a 12-inch diameter duct with an air speed of 1,000 feet per minute. Acceptable products: Genflex IL, Casco Silentflex, Cody West type NILS, Modular Flex Acoustical Core Flexible Duct, Modular Metal Fabricators, Inc.

<table>
<thead>
<tr>
<th>Frequency, Hz</th>
<th>Sound Power Levels, dBA: 10-12 Watts, at Octave Band Center Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>30</td>
</tr>
<tr>
<td>250</td>
<td>31</td>
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<tr>
<td>500</td>
<td>30</td>
</tr>
<tr>
<td>1000</td>
<td>22</td>
</tr>
<tr>
<td>2000</td>
<td>20</td>
</tr>
</tbody>
</table>

2. Do not use flexible duct for duct connections through walls or gypsum board ceilings.

E. Gasket Material:

1. For use with registers, grilles, and diffusers installed in exposed uninsulated ductwork: 1/4-inch thick felt or sponge rubber material, of width as required by the flange on the particular device.

2. For use with flanged joints in ducts: 1/8-inch thick reinforced inert plastic of the self-conforming type, of width as required by the particular flange.

F. Duct Tape and Sealants:

1. Hardcast DT-5400 tape with McGill AirSeal Corp United Duct Sealer (VOC=302g/l required for LEED credit).

2. or equal

G. Duct Access Doors:

1. Provide access doors a minimum of 12-inch by 12-inch in size, fabricated of the same material, finish and gauge as the ductwork in which installed, unless otherwise shown. In ducts with maximum dimension less than 14 inches, provide bolted flanged section minimum 18 inches long.

2. In uninsulated ducts provide folded edges on all four sides of door panels, lapping 1-inch over the outside surface of the duct, on each of the four edges of the duct opening. Provide each door with a continuous hinge and with 2 casement fasteners for doors over 16 inches high.

3. In insulated ducts provide hollow metal doors of thickness to match insulation, fabricated from a minimum of No. 20-gauge sheet. Design lock edge of doors with a bevel of 1/8-inch in 1-inch and fill the interior hollow space with insulation, thermally equivalent to the ductwork insulation. Lap the inner face of the door over the duct opening, a minimum of 1/4-inch on all four edges of the free duct opening. Frame the duct opening for each door with a continuous 1-inch by 1-inch by No. 12-gauge sheet metal angle, of the same material as the duct in which installed, riveted to the exterior surface of the door.
the duct opening. Provide each door with a continuous hinge and a surface type latch with inside striker for contracting inside of door framing, so as to provide a compression fit. Provide doors over 16 inches high with a minimum of two latches. Provide all doors with 3/4-inch wide sponge rubber or felt gasket, around all four sides of duct opening similar to Ruskin ADH series.

H. Duct Access Door Hardware:

1. Butt Hinges: Provide galvanized steel with brass pins, approximately 2-inches by 1-1/2-inches wide for doors under 25-inches high and 3-inches by 2-inches wide for doors over 24-inches high.

2. Casement Fasteners: Steel or cast aluminum with galvanized or aluminized finish.

3. Door Latches: Ventfabrics, Inc. Ventlock No. 260 or Duro Dyne Corp. Code No. SP Series, or equal.

I. Fire Dampers and Smoke Dampers:

1. All fire dampers and combination fire and smoke dampers shall conform to CMC Chapter 6, Section 606, and be listed by the Office of the State Fire Marshal.

2. Substantiation of California State Fire Marshal listing and installation details shall be submitted in accordance with the requirements of Section 15010 General Mechanical Requirements.

3. Dampers operating with blades closing in any direction other than by gravity pull shall be assisted in closing by a heat resistant, reel-type stainless steel spring.

4. Fire-damper installation is required for all ductwork which penetrates fire rated walls, floors and ceilings. Every effort has been made to show all fire dampers on the Mechanical Drawings. The Architectural Drawings indicate by symbol all such fire rated partitions. The Contractor shall verify all locations and provide fire dampers which are required but not shown on the Mechanical Drawings at no increase in the Contract Sum. Installation shall conform in all respects to the requirements of the State Fire Marshal.

5. All fire dampers and combination fire and smoke dampers shall be guaranteed by the manufacturer to close against air flow at 4000 feet per minute at 4 inches wg pressure.

J. Fire Dampers Inside Ducts:

a. Vertical and/or horizontal type dampers for installation in one or two-hour fire resistive construction shall be the folded blade type.

b. All fire dampers shall be mounted in a sleeve by the manufacturer, of the gauge for which it is approved.

c. Provide 100-percent free area dampers where fire dampers are shown, Ruskin, Air Balance, or equal, in folded blade type; Type B for rectangular ducts, Type CR for round ducts.

K. Combination Fire and Smoke Dampers:

1. UL 555S Class I labeled.

2. Installed in factory fabricated wall sleeve.

3. Rectangular dampers to have hollow airfoil blades.

4. Actuator shall meet the following requirements.

   a. 120 VAC, rated for 350 degrees F operation, factory installed.
b. Sized for 125 percent of the required torque based on the damper size, direct coupled.

c. Incorporate a latching mechanism, such that the motor is switched off when the damper has reached the fully open position and the latching mechanism, which is solenoid operated, holds the damper open. If the control system requires the damper to close, the latching mechanism shall be withdrawn and the damper shall close by spring operation.

5. Provide pilot light assembly consisting of a green and red pilot light, surface mounted in the corridor in the vicinity of the damper, to indicate if the damper is open or closed. Ruskin MCP3 or equal.

a. The damper assembly shall be tested for 100,000 cycles and shall be 99 percent reliable when cycled once a year. Damper assemblies requiring more frequent cycling are not acceptable.

b. Provide Ruskin SP100 position indicator switch package, or equal.

c. Ruskin FSD60, FSDR25, Nailor, Pottorff, or equal.

2.05 Underfloor Fan Powered Terminal Unit

A. Acceptable Manufacturers:

1. Price Industries.

2. Or approved equal.

B. Construct assembly casing of not lighter than 22 gauge zinc coated steel with height not exceeding 12 1/2”. Casing sides shall be internally lined with 1/2 inch thick, 1.5 pcf min. density fiberglass insulation complying with UL-181 and NFPA-90A. Any cut edges of fiberglass exposed to the airstream shall be coated with NFPA-90A approved sealant.

C. Unit shall fit within the pedestals of a conventional 24”x24” raised floor system. Unit casing shall have a top access door to allow removal of fan and servicing of unit. Fan blower shall be constructed of steel with forward curved blades, dynamically balanced wheels and direct drive motor.

D. Motors shall be GE ECMTM DC brushless motors complete with and operated by a single phase integrated controller / inverter that operates the wound stator and sensor motor position to electronically commutate the stator. All motors shall be permanently lubricated with ball bearings. Motor shall maintain a minimum of 70% efficiency over its entire operating range. Motor shall be direct coupled to the blower. Provide isolation between motor and blower assembly. Provide manual fan speed control for field adjustment of the fan air flow setpoint.

E. Units shall include integral backdraft damper to prevent plenum air flow through non-operating fan.

F. Units shall incorporate a single point electrical and control connection for the entire unit. All electrical components shall be enclosed in a single control box with an access panel mounted on the side of the assembly. All controls shall be sealed from airflow. Units shall be ETL listed to meet UL1995 and CSA No. 236.

G. Speed control shall accept a 0-10 VDC or 0-20 mA signal, as required by Section 17900, for remote fan adjustment from the Building Management System.

H. The following equipment shall be supplied by Section 17900 Building Management System, and installed by the fan powered terminal manufacturer:

1. DDC microprocessor based controller.

2. Pressure transducer, if it is not contained in the DDC microprocessor.
I. Section 17900 shall furnish the DDC unit controller and flow transducers (if not integral with the unit controller) to the terminal unit manufacturer's factory along with written instructions and drawings containing sufficient information to enable the terminal unit manufacturer to undertake the installation. The terminal unit manufacturer shall prepare a drawing of the wiring for the terminal unit controller and all associated instrumentation and final control elements based on the information provided by Section 17900. The terminal unit manufacturer shall not make any factory adjustments to the DDC unit controller or enter any data into the DDC unit controller in any way. All testing, entry of data and adjustments of any kind to the unit controller shall be undertaken by the BMS vendor at the project site.

J. Coordinate with Section 17900 to ensure that the electric actuator is capable of operating in the stalled position without overheating or mechanical damage.

K. All primary air control components shall be mounted inside a protective metal shroud.

L. Provide hot water reheat coils as scheduled. Provide a quick opening access panel to allow cleaning and inspection of the coil. The coils shall be constructed of 0.500”x0.017” copper tube. Fins shall be 0.0045” thick aluminum sine wave configuration. The coil shall be contained in a 0.030” galvanized steel casing and pressure tested to 349 PSIG at 300°F tube surface temperature. Coil shall be tested and certified according to ARI Standard 410. Coil connections can be right hand or left hand as shown on the drawings or as required for proper operation and maintenance of units.

PART 3 – EXECUTION

3.01 Duct Installation - General

A. Installation of ducts shall conform to requirements of CMC Chapter 6, Section 604.

B. Install ductwork to provide maximum headroom. Properly seam, brace, stiffen, support, and render ducts mechanically airtight. Adjust ducts to suit local conditions and if necessary to accomplish this, dimensions may be changed but only after review by the University’s Representative. Cross-sectional area shall be maintained.

C. If beading is substituted for crossbreaking transverse reinforcing must be increased such that no panel deflection exceeds plus or minus 5 mils, when system is operating. Beading to be at right angles to air flow.

D. Provide ductwork connected to air handling equipment or air inlet and outlet devices, with all necessary transformation pieces, flexible fabric connections, as required.

E. Joints and Seams: Tape all plenum joints and all duct transverse joints and field formed seams air tight in accordance with CMC Chapter 6, Section 604.4. Tape shall be Hardcast DT-5400 tape and RTA-50 sealer. Tape shall be extended a minimum of one-inch beyond joint or seam opening. Apply tape internally in large supply plenums and externally in large exhaust plenums. Tape shall also be applied at duct connection to diffusers and grilles, and at all longitudinal button lock seams.

F. All seams and joints in ductwork exposed to the weather shall be waterproofed by application of Hardcast DT-5400 tape and RTA-50 sealer, or equal.

G. Where internal insulation is applied, duct sizes as shown on the Drawings shall be inside clear dimensions.

H. Notify the University’s Representative where duct dimension field changes are required in order to conform with the building structure or to avoid interfering with other work.

I. Provide access door whether indicated on the drawings or not for the following:

1. Fire dampers and combined fire and smoke dampers.

2. At direct drive fans.

3. At flow switches.
4. Where access is required to assemble duct mounted devices.
5. Where access is needed for duct cleaning.

J. Install duct detector (furnished by Division 16) at each combination fire-smoke damper. Install pilot light assembly centered in a ceiling file. Coordinate location of duct detectors with Balancing Contractor to ensure that duct detectors will meet manufacturer's minimum differential pressure requirements.

K. All fume hood duct system upstream of fans shall be watertight. Test all fume hood ducts at 10 inch W.C. and coat seams with soap solution to prove tightness.

L. Ducts and duct supports must not contact ceiling framing and wires.

M. Flexible duct will be installed only where shown on mechanical design drawings. Where flexible duct is installed, the following restrictions apply:
   1. Maximum turn angle 90 degrees;
   2. Minimum inside radius one duct diameter;
   3. Limit of two bends per flexible duct;
   4. Limit flexible duct overall length to 8-feet maximum.

3.02 Hangers For Ducts (See also Section 15200 Noise, Vibration and Seismic Control)

A. Install hangers for ducts as specified in the CMC Chapter 6 and as follows:
   1. For rectangular ducts up to 42-inches wide, supported from overhead construction, extend band hangers down over each side of the duct and turn under bottom of duct a minimum of 2-inches. Secure hanger to duct with three sheet metal screws, one in the bottom and two in the side of the duct.
   2. For rectangular ducts 43-inches to 60-inches wide, supported from overhead construction, secure band hangers to ducts by bolting with 3/8-inch bolts to the horizontal joints.
   3. For round and flat oval ducts, see drawings for arrangement, size hangers and braces as for rectangular ducts.
   4. For exposed ducts do not support from channel underneath duct, support from angle or channel on top of duct.

3.03 Under Hager Attachments

A. General:
   1. Provide blocking where connecting beam angle clips to joists.
   2. Provide blocking and unistrut where hangers attach at a point between joist locations.

3.04 Adjustment and Cleaning

A. Clean ductwork inside and out before grilles are installed and before fans are operated.

3.05 Duct Liner: To be used only where specifically shown.
A. Install in accordance with SMACNA standards for the application of duct liner and the following.

1. All portions of duct designated to receive duct liner shall be completely covered with liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The black coated side of the liner shall face the air stream. Duct liner shall be adhered to the sheet metal with 100 percent coverage of adhesive, and all leading edges and all transverse joints coated with adhesive in accordance with ASC-7001C.

2. Liner shall be additionally secured in accordance with SMACNA standards with mechanical fasteners, which shall compress the duct liner sufficiently to hold it in place. Cut duct liner to assure overlapped and compressed longitudinal corner joints.

3. Liner for round ducts shall be rigid scored board or preformed round Fiber Glass similar to Casco Circliner, Schuller "Spiracoustic", or equal.

4. All acoustical duct lining shall incorporate means to prevent fiber entrainment in the air stream.

5. Acceptable product for lining rectangular section ducts and plenums: Certainteed "ToughGard" or approved equivalent.

6. Minimum sound-absorption coefficients (ASTM C423 Mounting Type A)* for sound-absorbing duct lining material:

<table>
<thead>
<tr>
<th>Octave Band Center Frequency, Hz.</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot; thickness lining, 2.0-3.0 pcf density</td>
<td>.05</td>
<td>.25</td>
<td>.50</td>
<td>.70</td>
<td>.85</td>
<td>.85</td>
</tr>
<tr>
<td>2&quot; thickness lining, 2.0-3.0 pcf density</td>
<td>.25</td>
<td>.50</td>
<td>.80</td>
<td>.90</td>
<td>.90</td>
<td>90</td>
</tr>
</tbody>
</table>
7. Where acoustically lined circular or oval duct is required, lining shall be positively retained in place. Acceptable manufacturers of pre-fabricated, internally lined duct include United McGill and Sheet Metal Products.

8. All duct lining shall be 1" unless otherwise noted on the drawings.

3.06 Flexible Fabric Connectors (Installation)

A. Make ductwork connections to air handling equipment with flexible fabric connectors. Install connectors so as to have sufficient slack to prevent vibration transmission.

B. Secure fabric connectors to fans, casings and ducts as follows:
   1. Secure round connectors with No. 12 USS gauge by 1-inch wide galvanized steel draw bands. Secure bands with bolts and nuts.
   2. Secure rectangular connectors with 1-inch by 1/8-inch thick flat galvanized steel bars, with screws or bolts on 8-inch centers maximum, or with sheet metal slip joints. Tightly crimp fabric into sheet metal joint and secure complete joint with sheet metal screws on 6-inch centers maximum.

C. Fabric connectors may be factory pre-fabricated, pre-assembled units, with minimum No. 24-gauge metal edges, secured to fabric with double lock seams.

D. Do not paint fabric connectors.

E. Fabric connectors exposed to weather shall have a sheet metal shield to protect them from sunlight fastened to one edge of the connection.

3.07 Flexible Duct Connectors

A. Flexible Air Duct Connectors installation shall be in accordance with CMC Chapter 6 and UMC Standard 6-5, and length shall not exceed 3 ft. and angular deflection shall not exceed 15 degrees.

3.08 Damper Hardware

A. Duct Damper Hardware: Install where immediate access to dampers is not available. Hardware shall be Ventfabrics "Ventlock" in accordance with Part 2 - Products.

B. Provide all couplings, joints, screws, rods, linkages, etc., to complete the installation.

3.09 Schedules

A. See Air Distribution Device Schedule for type, size and code numbers of air outlets.

END OF SECTION
SECTION 15990

TESTS AND BALANCING

PART 1 – GENERAL

1.01 Summary of Work

A. Balance all building air-conditioning equipment and systems. All air outlets and inlets shall be balanced to values shown on the drawings.

B. Balance heating hot water system.

1.02 Quality Assurance

A. Applicator ( Erector ) Qualifications:

1. System balancing shall be done by a firm regularly engaged and specializing in the field of air and water balancing. Testing and balancing shall be performed in complete accordance with the National Standards for Total System Balance, as published by the Associated Air Balance Council (AABC). The Contractor must be AABC or NEBB certified.

2. The air and water balancing firm must have experience in projects in similar type and scope and shall submit a list of names and qualifications of all personnel proposed to do this Work. A detailed description of the procedures and the instrumentation employed shall accompany the personnel list. Only experienced personnel and rational orderly procedures will be accepted.

3. The air and water balancing contractor shall contract directly with the general contractor and shall not be a sub to the mechanical contractor.

4. The final balance report shall be certified by a registered professional engineer. Submit the qualifications of the supervisor and engineering technician for review. Personnel shall have past experience of such nature that qualifies them for balancing of these systems. Provide final balance report to the State Fire Marshal.

B. The mechanical contractor shall cooperate with the balancing contractor in the following manner:

1. Performance of prebalancing requirements of Section 15010, "Mechanical General Requirements".

2. Inform Balancing Contractor of any major changes made to mechanical systems during construction.

3. Perform pressure testing of piping systems as specified herein.

4. Provide dynamic balancing of equipment as specified in Section 15010.

C. Referenced Standards:

1. AABC - Associated Air Balance Council.
   a. National Standards.

2. American Society of Mechanical Engineers
   a. ASME/ANSI B31.9 Building Services Piping
3. SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

1.03 Submittals

A. Balancing Procedure:
   1. Submit procedure to be followed for air and water balancing, including:
      a. Detailed procedures.
      b. Agenda for this Project.
      c. Report forms.
      d. Project performance guarantee.

B. Test Reports:
   1. Submit six copies of the balance report typed in final form.
   2. Submit a written report as necessary, describing any component, i.e., fan drive, damper, pump, valve, etc., which does not function properly.

C. Qualifications:
   1. Submit qualifications of balancing firm and testing personnel.

PART 2 – PRODUCTS

2.01 Materials

A. Products and Materials as specified in Part 3 of this Section and related Sections.

PART 3 – EXECUTION

3.01 Air and Water Balancing

A. Study the Specifications and Drawings and prepare schedule to inspect equipment of air and water systems.

B. Make field inspection prior to closing in portions of systems to be balanced. Verify that all work, fittings, dampers, balancing devices, etc., are properly fabricated and installed as specified or shown and that proper balancing can be done.

3.02 Preparation

A. Prepare test and balancing procedures schedule, test record forms and technical information about the air and water systems necessary to balance Work.

3.03 Installation/Application/Performance/Erection

A. Test and Balance Service:
   1. The test and balance services shall be performed upon completion of the air handling and water systems and after completion of general operating tests described under Prebalancing Requirements in Section 15010, “Mechanical General Requirements”, and after the Work specified above.
2. Recommend adjustments and/or corrections to equipment and air and water systems necessary for proper balancing and submit to the University Representative.

B. Performances and Capacity Checks: Readings shall be taken as shown, specified and as required to demonstrate that the following equipment is operating in accordance with the manufacturer's published ratings:

1. AHU-S-3A and AHU-S-3B
2. Controls.
3. Coils.
4. Air inlets and outlets: Air inlets and outlets of 200-cfm or less shall be balanced to within 10-percent of design; all other air system readings within 5-percent of design.
5. Fan power boxes.

C. Temperature readings shall be accurate to within .5 degree F.

D. Water flow readings shall be accurate to within five percent (5%).

E. Pressure readings shall be accurate to within 1/2-psi for water systems and 0.01-inch W.G. for air systems.

F. Recorded Data:

1. All readings, measurements, and observations shall be recorded on AABC or equivalent printed data sheets and tabulated with appropriate calculations. Recorded data shall include the following:

   a. Fan Performance Data:

      ACTUAL SPECIFIED

      CFM -----------------    ________   ________
      RPM -----------------    ________   ________
      SP+ -------------- -------     ________    ________
      SP ------------- -------     ________    ________
      TSP ----------------------       ________   ________
      Amperage ------- ---------    ________   ________
      Voltage --------------- ---       ________   ________
      Outside Air CFM ----------   ________   ________
      Return Air CFM ----------   ________   ________

      Outlet Data:
      Total CFM of Outlets -----  ________   ________
      Traverse Total -----            ________   ________

   b. Air velocities, entering and leaving air temperatures, entering and leaving water temperatures, air and water pressure drops, at reheat and cooling coils.

   c. Main and branch duct velocities and static pressures.

   d. Velocities specified and actual, air volume factors, design and calculated air volumes of supply, return, and exhaust air outlets, size of outlets.

   e. Room temperatures.

G. Spot Checking: After the balancing contractor has submitted his records of final readings and measurements for all systems, the University Representative will make spot checks of each system. If spot-check measurements
differ materially from those submitted, the University Representative will direct that the systems concerned be completely re-balanced in the presence of the Inspector and that new data be submitted. All systems shall be completely balanced and preliminary balance reports shall be submitted no later than the actual data of completion of balancing.

H. Air Balancing:

1. Air balancing procedures, methods and data recording and reporting shall be in accordance with the applicable portions of AABC National Standards, Chapter 16 through 24 and as specified herein.

2. The Contractor shall provide additional dampers and pressure plates where required to facilitate balancing and to prevent damper, grille and diffuser noise. All this Work shall be done at no increase in the Contract Amount.

3. Make adjustments at all diffusers and grilles to prevent drafts at the occupant level in the space. Portions of the diffusers and grilles shall be blanked behind these units as directed or required or blades shall be redirected in order to prevent or remove drafts.

4. The balancing report shall include a tabulation for each supply, return, exhaust fan system as follows:
   a. Diffuser/Design
   b. Measured
   c. Design Measured
   d. Design Measured
   e. Design
   f. grille # Room #
   g. Supply Return
   h. Return Exhaust
   i. Exhaust
   (1) Each grille/diffuser shall be identified on the tabulation and on a drawing to be included with balance report.

5. Fan speed may be adjusted to obtain scheduled flow. On completion of balancing drive sheaves shall be changed to restore VFD to 54mhz at 100% design flow.

6. Balancing contractor shall calibrate readings measured by the BAS system for air flow CFM at each fan powered variable air volume box. Balance report shall document any calibration factors applied.

7. For each FPB balancing report shall show final programmed factors used for setting required flow.

8. Balancer shall establish duct static pressure setpoints for all variable volume systems, provide this information to the controls contractor, and record this information in the Balancing Report. The setpoints shall be the lowest value possible to achieve the design CFM's.

9. Minimum outside air damper position shall be determined at maximum and minimum supply quantities on VAV systems (one at minimum expected fan speed and one at design fan speed),
and a characteristic provided to the control contractor.

I. Piping Pressure Test:

1. Plumbing piping shall be tested per CPC California Plumbing Code, 2001 Edition and the following.

2. Building service piping shall be examined and tested in accordance with ASME/ANSI B31.9 and the following.

3. Circulating Piping: Piping systems shall be pressure tested as follows: Test shall show no loss in pressure or visible leaks after a minimum duration of 4-hours with pressurization source removed.

   a. Following systems shall be hydrostatically tested to 150 psig:

      (1) Heating hot water supply and return.

      (2) Allowance may be made for water added or discharged to maintain pressure loss or gain due to temperature change.

4. Drainage, Waste, and Vent:

   a. The water test shall be applied to the system either in its entirety or in sections.

   b. The piping shall be tightly plugged and submitted to a head of water located at the highest point, or if tested in sections, to a point 10 ft above highest connection.

   c. The water shall be kept for at least 30 minutes before the inspection starts.

   d. System shall hold water for 4 hours without loss.

5. Sectionalizing:

   a. Parts of the system may be isolated for the purpose of testing.

   b. Each isolated part shall be specifically identified and certified.

J. Water Balancing:

1. Balance water flow through individual system components to within 5-percent of design quantities. Assure that all modulating control valves provide full throttling from wide open (design) flows to 100-percent shut-off. Verify control sequences, settings, and operation to all automatic control valves. Final position of balance valves shall be plainly marked after balancing is complete.

2. The water system shall be properly balanced for the water quantities by utilizing thermometer wells, time-quantity devices, and other line flow-measuring devices hereinafter specified. In closed systems, where no line devices are installed, use a surface pyrometer probe. During this period, all automatic valves shall be in the 100-percent open position.

3. Where pyrometers are used, surface temperature differentials shall be tabulated between inlet and outlet of heat exchange devices. Pyrometers shall have scale 0 degree F to 300 degree F, with 2 degree F graduations and appropriate pipe probe.

4. Water flow from plumbing fixture outlets shall be balanced for normal quantities by use of stops.

K. Testing of Fire and Smoke Dampers:

1. Test all fire and smoke dampers for proper operation. Test in accordance with local Fire Marshal requirements.
2. Provide documentation of testing indicating date of test, individuals present during testing, and “pass” or “fail” for each damper and/or duct detector. System testing shall not be complete until record indicates that all dampers and/or duct detectors have passed the test.

END OF SECTION
SECTION 15995

COMMISSIONING OF HVAC and BMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System specific commissioning for the HVAC Systems
   2. System specific commissioning for the Building Management and Control Systems

B. Related Sections
   1. 01810 – Commissioning General Requirements
   2. Division 16

1.2 DESCRIPTION OF WORK – refer to 01810

1.3 SUBMITTALS – refer to 01810

PART 2 - PRODUCTS – refer to 01810

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS AND PROCEDURES – refer to 01810

3.2 SYSTEM READINESS CHECKLISTS

A. Review and complete Systems Readiness Checklists in accordance with Section 01810.

B. Contractor’s Commissioning Coordinator shall verify completion of all items, sign and return the checklist to the Commissioning Authority as an indication of final completion with all installation criteria as specified in the Project Contract Documents.

C. To demonstrate the level of rigor required during this process, a sample System Readiness Checklist is provided later in this Section 15995. Initial checklists will be developed and delivered to the Contractor by the Commissioning Authority after equipment submittals have been accepted. The Contractor shall review the initial Systems Readiness Checklists for completeness and add items as necessary. After approval by the Commissioning Authority, the final Systems Readiness Checklists shall be inserted into the Contractor’s Systems Readiness Plan during the Pre-Functional Testing phase.

D. A separate completed checklist shall be submitted for each system and item of equipment within the commissioning scope of work, along with associated start-up forms as specified in 01810.

E. The Systems Readiness Checklists do not represent all the contract documents for the associated equipment. Completion of the items on this checklist does not release the contractor from requirements specified elsewhere.
3.3 SYSTEMS READINESS PLAN

A. The Contractor shall provide a Systems Readiness Plan and Manual in accordance with Section 01810.

3.4 TAB REVIEW

A. Testing, Adjusting and Balancing (TAB): TAB shall be provided by the Contractor in accordance with the project specifications. The TAB contractor shall support commissioning by submitting the preliminary TAB data for CxA review and participating on the Commissioning TAB Field Review, in which the TAB Contractor demonstrates specified results to the CxA after completion of final TAB.

B. Equipment tested: All HVAC systems & equipment

C. Demonstrate:
   1. Determination of the final setpoints for pump speed and fan speed control per the project specifications and AABC standards. Demonstrate for all setpoints.
   2. Airflow rates are balanced and adjusted per the project specifications and AABC standards.
      a. Demonstrate minimum outside airflow rates for all air handling equipment.
      b. Demonstrate a 10% sample for all other measurements.
   3. Hydronic system flow rates are balanced and adjusted per the project specifications and AABC standards.
      a. Demonstrate for all boilers, chillers, cooling towers, and distribution pumps.
      b. Demonstrate a 10% sample for all other measurements.
   4. Verify TAB of circulating domestic hot water system per the project specifications and AABC standards.
      Demonstrate a 10% sample.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. The Functional Performance Test (FPT) Procedures shall be developed, performed and demonstrated in accordance with Section 01810.

B. At a minimum, the contractors and equipment suppliers listed in the FPTs Minimum Participants Table in this section of the specifications are required to participate in developing, performing and demonstrating the indicated FPTs.

C. The initial FPT procedures shall be provided after review of the controls submittal. The final FPT procedures may be modifications of the initial FPT procedures, and FPT procedures may be added; modifications and additions to be made by the Commissioning Authority after equipment submittals have been accepted.

D. The Contractor’s Commissioning Coordinator shall coordinate the subcontractors, with the Commissioning Authority’s input, in developing, performing and demonstrating the Working FPT.

E. Functional testing shall consist of the following phases:
   1. Component testing:
      a. Component testing applies to all control input and output devices, including those provided by the equipment suppliers and those provided with the Energy Management and Control System (EMCS). Examples include but are not limited to: sensor assemblies, detectors, relays and switches, valves, dampers, and actuators.
      b. Component testing applies to thermometers and gauges.
      c. Component testing consists of demonstrating field I/O calibration and operation including but not limited to:
         1) Accuracy of sensors is within design temperature range as specified.
         2) Alarmed points report correctly to operator workstation.
         3) Accuracy and settings of binary switches and alarms is as specified, within design temperature range.
2. Systems Testing

   a. Operational Verification: After functional testing of the system components has been successfully completed, each sequence of operation and control system function shall be functionally tested, including those provided by the equipment suppliers and those provided with the Energy Management and Control System (EMCS). Each control loop shall be tested to verify stable control with the specified and appropriate responses.

   b. Integrated System Verification: After operational testing has successfully demonstrated that each system functions in accordance with the project documents, functional testing shall occur to verify that the interaction between the systems is as required. Each interactive function shall be functionally tested, including those provided by the equipment suppliers and those provided with the EMCS.

   c. Real Time Performance Analysis (trend logging):

      1) After operational testing has been successfully completed real time performance testing shall be performed. Data shall be logged for the intervals and periods specified in the FPT procedures. Unless otherwise specified in the FPTs, test periods shall include occupied, unoccupied, weekend, and holiday schedules.

      2) Analysis of the data shall demonstrate that the systems operate in accordance with the acceptance criteria specified in the FPT procedures. Verify that data demonstrates acceptable results before submitting for CxA review. If acceptable results are not demonstrated, perform testing and trouble shooting and corrective action to provide resolution. Provisions for retesting, as specified in 01810 shall apply to trend log analysis.

      3) In addition to the initial test period, data shall be logged during a peak heating period, a peak cooling period, and a transitional season period if so specified under FUNCTIONAL PERFORMANCE TEST (FPT) SEASONAL TESTING.

3.6 FUNCTIONAL PERFORMANCE TEST (FPT) SEASONAL TESTING

A. Perform seasonal testing in accordance with the specification for Real Time Performance Analysis, which is specified elsewhere in this section.

B. The following table indicates which FPTs include Seasonal Testing.

C. The key to the codes used in Seasons column of the table is as follows: W = winter/peak heating; SU = summer/peak cooling; SP = spring/heating to cooling transitional season; F = fall/cooling to heating transitional season

<table>
<thead>
<tr>
<th>FPT PROCEDURE</th>
<th>SEASONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating System</td>
<td>W</td>
</tr>
<tr>
<td>Cooling System</td>
<td>SU</td>
</tr>
</tbody>
</table>

3.7 FUNCTIONAL PERFORMANCE TEST (FPT) DEMONSTRATION SAMPLING

A. When a FPT applies to many similar components or systems that are not a part of a life-safety system, the contractor may demonstrate the functional performance tests (FPTs) to the Commissioning Authority (CxA) as specified in Section 01810. Demonstration Sampling will apply only in accordance with 01810, and only for the components and systems listed in the accompanying Functional Performance Test (FPT) Demonstration Sampling Table.

<table>
<thead>
<tr>
<th>FPT PROCEDURE</th>
<th>SAMPLE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>All major HVAC equipment (Air Handlers, Cooling Towers, Pumps)</td>
<td>All Units</td>
</tr>
</tbody>
</table>
3.8 FPT MINIMUM PARTICIPANTS TABLE:

A. At a minimum, the mechanical and BMS contractors will participate, demonstrating successful FPTs to the Commissioning Authority.

3.9 SAMPLE SYSTEM READINESS CHECKLIST

Instructions: Contractor shall submit a completed and signed copy of this checklist as an indication of compliance with all installation criteria specified in the Construction Documents.

---

**Electrical Installation:**

- Final wiring connections are complete.
- Control Panels are installed plumb and level
- Wiring is installed in a neat and workmanlike manner
- Wiring has been tagged with permanent labels per Construction Documents.
- Code-required electrical services clearance for all electrical components has been provided per Construction Documents.
- Installed junction boxes for any control wiring such that no motor starter or disconnect switches are used as junction boxes.
- An electrical receptacle is located within the control panel.
- Wiring is installed in conduit where required.
- There are no spices installed in panelboards.
- Rain-tight fittings installed where required
- Equipment has been properly grounded.

Signed: _____________________________   Date: ________  Company: ________________

---

**Control System Integration:**

- Sensors, controls, and points have been installed and verified operational.
- Sequences and interlocks have been programmed per Construction Documents.
- Wiring is installed in a neat and workman like manner.
- Alarms are operational and register at the BMS Operator's Interface.
- Zone thermostats control unit operation.
- A 5°F dead band between heating and cooling modes is available, either through BMS programming or via the thermostat.
- Control system has been programmed with occupied, unoccupied and holiday schedules, and these schedules have been documented for the owner.
- Control system has been programmed with night time set back setpoints, and these setpoints have been documented for the owner.
- Point-to-point record sheets are attached.

Signed: _____________________________   Date: ________  Company: ________________
Startup:

Commissioning Authority notified of and witnessed testing per Construction Documents.
Startup procedures and completed startup report attached.  
Internal controls have been verified operational.
Safety tested, adjusted and demonstrated to CxA.
Running and warning indicators tests have been demonstrated to CxA per Construction Documents.

Signed: _____________________________   Date: ________  Company: ________________

FPT Readiness:

Test and Balance (TAB) is complete with preliminary reports submitted to CxA. Balanced settings are marked clearly and indelibly on balance devices or set with mechanical stops.
Completed and signed copies of all start-up checklists/test forms provided to CxA.
Damaged factory finishes have been replaced, repaired or touched up.
Equipment not painted at factory has been painted with a finish coat of paint (no primer).
All known issues have been corrected or reported to the CxA and the systems are ready for the functional performance test phase of commissioning.

EQUIPMENT READY FOR FUNCTIONAL TESTING – Contractor's pre-functional testing is complete; contractor has verified that functional performance testing (FPT) of the equipment and associated system demonstrates acceptable results as specified in FPT procedures.

Signed: _____________________________   Date: ________  Company: ________________

This checklist is not intended to represent all the requirements of the Construction Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: _____________________________   Date: ________________

Contractor's Commissioning Coordinator

Signed: _____________________________   Date: ________________

Commissioning Authority

Outstanding Issues: _____________
3.10 SAMPLE FUNCTIONAL PERFORMANCE TESTS:

**AH-1 SYSTEM FUNCTIONAL PERFORMANCE TESTS**

**A) OBJECTIVES**
1) To perform comprehensive testing of all control related components and their driven devices (e.g. VFDs, temperature sensors, dampers and actuators). Demonstrate that the DDC system Operator's Graphics for the air handling unit (AH) are accurate schematic representations, which include the specified data points and information.

2) Specifically this test will check that:
   a) Temperature sensors are located and calibrated such that they are accessible for maintenance and the measurement accurately represents the average temperature of the specified fluid and location
   b) Coil control valves fully shut off flow to coils when closed and fully open when commanded
   c) Supply Air Temperature (SAT) control is operating per Sequences of Operation.
   d) Alarms are implemented and are operating properly
   e) VFD panel readout accurately reflects same as EMS.

**B) EQUIPMENT TESTED**
1) Air Handling Numbers: AH-P1 includes Supply Fan AH-P1.

**C) BASIS OF TEST**
1) Project specifications and drawings
2) Control logic based on the sequences of operation as shown below

**D) AHU-1 SEQUENCE OF OPERATIONS**

**A.** Run Conditions:
1. WHEN SUPPLY FAN IS STOPPED, BOTH VALVES WILL CLOSE, THE MINIMUM OUTSIDE AIR DAMPER WILL CLOSE AND THE RETURN AIR DAMPER WILL CLOSE.
2. THE SUPPLY FAN IS INDIVIDUALLY STARTED AND STOPPED THROUGH A TIME-OF-DAY, DAY-OF-WEEK, AND HOLIDAY SCHEDULE (24/7) OR THRU OPERATOR'S COMMAND. CSR1 (CURRENT SWITCH/RELAY) MOUNTED AT VARIABLE SPEED DRIVE WILL PROVIDE START/STOP AND STATUS FUNCTION. THE RETURN AIR DAMPER WILL OPEN FIRST, THEN WHEN DAMPER OPEN STATUS IS CONFIRMED, START THE SUPPLY FAN.

**B.** High Static Shutdown:
1. THE UNIT SHALL SHUT DOWN AND GENERATE AN ALARM UPON RECEIVING A HIGH STATIC SHUTDOWN SIGNAL (DPS2).
2. MANUAL RESET IS REQUIRED TO RESTART THE SYSTEM.

**C.** Supply Air Smoke Detection:
1. THE UNIT SHALL SHUT DOWN AND GENERATE AN ALARM UPON RECEIVING A SUPPLY AIR SMOKE DETECTOR STATUS.

**D.** Supply Fan:
1. THE SUPPLY FAN SHALL RUN AT ALL TIMES, UNLESS SHUTDOWN ON SAFETIES. TO PREVENT SHORT CYCLING, THE SUPPLY FAN SHALL HAVE A USER DEFINABLE (ADJ.) MINIMUM RUNTIME.

2. ALARMS SHALL BE PROVIDED AS FOLLOWS:
   A. SUPPLY FAN FAILURE: COMMANDED ON, BUT THE STATUS IS OFF.
   B. SUPPLY FAN IN HAND: COMMANDED OFF, BUT THE STATUS IS ON.
   C. SUPPLY FAN RUNTIME EXCEEDED: STATUS RUNTIME EXCEEDS A USER DEFINABLE LIMIT (ADJ.).

E. SUPPLY AIR DUCT STATIC PRESSURE CONTROL:
   1. THE CONTROLLER SHALL MEASURE DUCT STATIC PRESSURE AND SHALL MODULATE THE SUPPLY FAN VFD SPEED TO MAINTAIN A DUCT STATIC PRESSURE SETPOINT OF 1.5 IN H2O (ADJ.). THE SUPPLY FAN VFD SPEED SHALL NOT DROP BELOW 10% (ADJ.).
   2. ALARMS SHALL BE PROVIDED AS FOLLOWS:
      A. HIGH SUPPLY AIR STATIC PRESSURE: IF THE SUPPLY AIR STATIC PRESSURE IS 25% (ADJ.) GREATER THAN SETPOINT.
      B. LOW SUPPLY AIR STATIC PRESSURE: IF THE SUPPLY AIR STATIC PRESSURE IS 25% (ADJ.) LESS THAN SETPOINT.
      C. SUPPLY FAN VFD FAULT.

F. SUPPLY AIR TEMPERATURE SETPOINT- OPTIMIZED:
   1. THE CONTROLLER SHALL MONITOR THE SUPPLY AIR TEMPERATURE AND SHALL MAINTAIN A SUPPLY AIR TEMPERATURE SETPOINT RESET BASED ON SUPPLY FAN VFD SPEED.
   2. THE SUPPLY AIR TEMPERATURE SETPOINT SHALL BE RESET BASED ON SUPPLY FAN SPEED PER THE FOLLOWING TABLE:

<table>
<thead>
<tr>
<th>SF SPEED</th>
<th>SAT SETPOINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>55°F</td>
</tr>
<tr>
<td>75%</td>
<td>60°F</td>
</tr>
<tr>
<td>50%</td>
<td>65°F</td>
</tr>
<tr>
<td>25%</td>
<td>70°F</td>
</tr>
</tbody>
</table>

G. HEATING AND COOLING COIL VALVES:
   1. THE CONTROLLER SHALL MEASURE THE SUPPLY AIR TEMPERATURE AND MODULATE THE HEATING AND COOLING COIL VALVES IN SEQUENCE TO MAINTAIN SAT SETPOINT.
   2. THE COOLING SHALL BE ENABLED WHENEVER:
      A. THE SUPPLY FAN STATUS IS ON
      B. AND THE HEATING VALVE IS NOT ACTIVE.
   3. ALARMS SHALL BE PROVIDED AS FOLLOWS:
      A. HIGH SUPPLY AIR TEMP: IF THE SUPPLY AIR TEMPERATURE IS 5°F (ADJ.) GREATER THAN SETPOINT.

H. LOW SUPPLY AIR TEMPERATURE ALARM:
   1. THE CONTROLLER SHALL ALARM IF THE SUPPLY AIR TEMPERATURE IS LESS THAN 45°F (ADJ.).

I. BUILDING STATIC PRESSURE CONTROL:
   1. THE FIRST FLOOR SPACE STATIC PRESSURE SENSOR IS FOR MONITORING ONLY.

J. PRE AND FINAL FILTER STATUS:
   1. THE CONTROLLER SHALL MONITOR THE PRE AND FINAL FILTER STATUS.
   2. ALARMS SHALL BE PROVIDED AS FOLLOWS:
      A. FINAL FILTER CHANGE REQUIRED: FINAL FILTER DIFFERENTIAL PRESSURE EXCEEDS A USER DEFINABLE LIMIT (ADJ.).

K. MIXED AIR TEMPERATURE:
1. ALARMS SHALL BE PROVIDED AS FOLLOWS:
   A. HIGH MIXED AIR TEMP: IF THE MIXED AIR TEMPERATURE IS GREATER THAN 90ºF (ADJ.).
   B. LOW MIXED AIR TEMP: IF THE MIXED AIR TEMPERATURE IS LESS THAN 45ºF (ADJ.).

L. RETURN AIR TEMPERATURE:
   1. ALARMS SHALL BE PROVIDED AS FOLLOWS:
      A. HIGH RETURN AIR TEMP: IF THE MIXED AIR TEMPERATURE IS GREATER THAN 90ºF (ADJ.).
      B. LOW RETURN AIR TEMP: IF THE MIXED AIR TEMPERATURE IS LESS THAN 45ºF (ADJ.).

M. SUPPLY AIR TEMPERATURE:
   1. THE CONTROLLER SHALL MONITOR THE SUPPLY AIR TEMPERATURE.
   2. ALARMS SHALL BE PROVIDED AS FOLLOWS:
      A. HIGH SUPPLY AIR TEMP: IF THE MIXED AIR TEMPERATURE IS GREATER THAN 120ºF (ADJ.).
      B. LOW SUPPLY AIR TEMP: IF THE MIXED AIR TEMPERATURE IS LESS THAN 45ºF (ADJ.).

E) PREREQUISITES
   1) The following items must be completed prior to performing the testing procedures:
      a) Final installation of this system component, including final connection to the EMS system – installation verification forms accepted.
      b) Equipment to be controlled is operational.
      c) EMS system operator’s graphical interface is complete for the systems involving these components.

F) MINIMUM PARTICIPANTS
   1) The following personnel should be present for the testing:
      a) Owner’s witnesses
      b) Contractor’s representative: commissioning coordinator
      c) Test technician: EMS system contractor
      d) Commissioning Authority

G) TEST EQUIPMENT
   1) The following test equipment is required to complete this procedure:
      a) Calibrated temperature measuring instruments capable of reading the temperature of the fluid within the specified tolerance and accuracy per the project documents
      b) Calibrated differential air pressure or flow measuring instrument capable of measuring the differential air pressure or air flow per the project documents

H) PROCEDURE
   1) Participants sign in on the log below.
   2) Record the equipment data on the next table.
   3) Verify the prerequisites as shown. If any prerequisite fails, remedy the failure and verify the remedy before continuing.
   4) Follow the step by step instructions in each step following.
5) Command and view all points from the EMS graphic user interface. Describe any deviation, or elaboration, on the test procedure in the Notes sections. Attach additional pages for notes if necessary. To facilitate photocopying, do not write on the backs of forms.

I) PARTICIPANT SIGN-IN

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Initials</th>
<th>Company</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner’s Witness</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Contractor’s Cx Coordinator</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tech: EMS system contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning Authority</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

J) TEST EQUIPMENT RECORD

1) Record the make, model, serial number and last calibration date for each piece of equipment used during the test.

<table>
<thead>
<tr>
<th>Make</th>
<th>Model</th>
<th>Serial Number</th>
<th>Last Calibration Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

K) PREREQUISITES

1) Verify the following prerequisites. Initial the pass or fail line and record the date and time.

| a) Final installation of system components, including final connection to the EMS system – installation verification forms accepted | Pass: _____ Date: _____ |
| b) Equipment to be controlled is operational.                                                               | Fail: _____ Time: _____  |

Pass: _____ Date: _____  
Fail: _____ Time: _____
c) EMS System operator's graphical interface is complete for the systems involving these components.

<table>
<thead>
<tr>
<th>Trend</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Fan Start/Stop AH-P1</td>
<td>COV*</td>
</tr>
<tr>
<td>Mixed Air Temperature</td>
<td>2 min</td>
</tr>
<tr>
<td>Outside Air Temperature</td>
<td>2 min</td>
</tr>
<tr>
<td>Filter Status</td>
<td>2 min</td>
</tr>
<tr>
<td>Return Air Temperature</td>
<td>2 min</td>
</tr>
<tr>
<td>Smoke</td>
<td>2 min</td>
</tr>
<tr>
<td>Supply Air Temperature</td>
<td>2 min</td>
</tr>
<tr>
<td>Duct Static</td>
<td>2 min</td>
</tr>
<tr>
<td>High Limit Switch</td>
<td>COV*</td>
</tr>
<tr>
<td>AH-P1 Supply Fan Status</td>
<td>2 min</td>
</tr>
<tr>
<td>Supply Fan Airflow</td>
<td>2 min</td>
</tr>
<tr>
<td>Outside Airflow</td>
<td>2 min</td>
</tr>
<tr>
<td>AH-P1 Damper Position</td>
<td>2 min</td>
</tr>
<tr>
<td>AH-P1 Cooling Valve</td>
<td>2 min</td>
</tr>
<tr>
<td>AH-P1 Heating Valve</td>
<td>2 min</td>
</tr>
<tr>
<td>SF Fan Speed AH-P1</td>
<td>2 min</td>
</tr>
<tr>
<td>SF VFD Alarm</td>
<td>2 min</td>
</tr>
</tbody>
</table>

COV = Change of Value but at least once every 24 hours

END OF PREREQUISITES PROCEDURE

L) TESTING PROCEDURE

1) The majority of the testing will be accomplished via trend analysis. Please keep in mind and follow the requested waiting times between certain steps to allow the system time to respond to the changes being made.

2) In addition to waiting the appropriate times, recording the time of test steps is critical in allowing the tester to locate the events in the trend logs.

3) Ensure the system is running normally before beginning the test.

4) Record the date of the test: ______________

5) Hot Water and Chilled Water Valve Leak-by Test
a) Time: ________ Set the fan VFD to 25% or less to provide a low airflow condition
b) Time: ________ Override the hot water coil valve to 0% open
c) Time: ________ Override the chilled water coil valve to 0% open
d) Time: ________ Close the manual isolation valves to the hot water coil
e) Time: ________ Close the manual isolation valves to the chilled water coil
f) Time: ________ Allow the system to run for 10 minutes
g) Time: ________ Record the outside air temperature and supply air temperatures
   (i) OAT: _______
   (ii) SAT: _______
h) Time: ________ Open the manual isolation valves on the hot water coil
i) Time: ________ Allow the system to run for 10 minutes
j) Time: ________ Record the outside air temperature and supply air temperatures
   (i) OAT: _______
   (ii) SAT: _______
   (iii) The SAT should not change more than .5°F during this time period, if it does, this may indicate a leaking control valve
k) Time: ________ Open the manual isolation valves on the chilled water coil
l) Time: ________ Allow the system to run for 10 minutes
m) Time: ________ Record the outside air temperature and supply air temperatures
   (i) OAT: _______
   (ii) SAT: _______
   (iii) The SAT should not change more than .5°F during this time period, if it does, this may indicate a leaking control valve

n) Time: ________ Clear all overrides including the fan VFD speed and allow the system to return to normal operation

6) Duct Static Pressure Control Test
   a) Time: ________ Record the current Supply Fan duct static pressure setpoint, static pressure, and VFD speed.
      (i) Supply Fan duct static pressure setpoint _______
      (ii) Supply Fan duct static pressure _______
(iii) Supply Fan VFD Speed

b) Time: _________ Change the Supply fan Static Pressure Setpoint by 0.25" w.c.

c) Allow the system to run for 5 minutes (or until stable)

d) Time: _________ Record the current Supply Fan duct static pressure setpoint, static pressure, and VFD speed.
   (i) Supply Fan duct static pressure setpoint
   (ii) Supply Fan duct static pressure
   (iii) Supply Fan VFD Speed

e) Change the duct static pressure setpoint back to its original value

f) Allow the system to run for 5 minutes (or until stable)

g) Time: _________ Record the current Supply Fan duct static pressure setpoint, static pressure, and VFD speed.
   (i) Supply Fan duct static pressure setpoint
   (ii) Supply Fan duct static pressure
   (iii) Supply Fan VFD Speed

7) Building Pressure Control Test
   a) Time: _________ Record the current building static pressure
      (i) Building Static Pressure
      (ii) Verify Building is slightly positive
      (iii) Confirm the variation in Building Space Static in section 6 above

8) Supply Air Temperature Control Test

<table>
<thead>
<tr>
<th>SF SPEED</th>
<th>SAT SETPOINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>55°F</td>
</tr>
<tr>
<td>75%</td>
<td>60°F</td>
</tr>
<tr>
<td>50%</td>
<td>65°F</td>
</tr>
<tr>
<td>25%</td>
<td>70°F</td>
</tr>
</tbody>
</table>

   a) Time: _________ Record the current VFD Speed and supply air temperature setpoint
      (i) VFD Speed:
(ii) SAT Setpoint: __________

b) Time: __________ Change the supply air temperature setpoint by changing the supply fan VFD speed to 100%. (Note – Monitor duct static pressure to ensure it does not rise above 3.0” w.c.)

c) Time: __________ Record the new supply air temperature setpoint
   (i) SAT Setpoint: __________ (Should be 55ºF)

d) Allow the system to run for 1 minute

e) Record the supply air temperature
   (i) SAT: __________

f) Time: __________ Change the supply air temperature setpoint by changing the supply fan VFD speed to 75%. (Note – Monitor duct static pressure to ensure it does not rise above 3.0” w.c.)

g) Time: __________ Record the new supply air temperature setpoint
   (i) SAT Setpoint: __________ (Should be 60ºF)

h) Allow the system to run for 10 minutes

i) Record the supply air temperature
   (i) SAT: __________

j) Time: __________ Change the supply air temperature setpoint by changing the supply fan VFD speed to 50%.

k) Time: __________ Record the new supply air temperature setpoint
   (i) SAT Setpoint: __________ (Should be 65ºF)

l) Allow the system to run for 10 minutes

m) Record the supply air temperature
   (i) SAT: __________

n) Time: __________ Change the supply air temperature setpoint by changing the supply fan VFD speed to 25%.

o) Time: __________ Record the new supply air temperature setpoint
   (i) SAT Setpoint: __________ (Should be 70ºF)

p) Allow the system to run for 10 minutes
q) Record the supply air temperature
   (i) SAT: __________

r) Clear all overrides and alarms to restore the unit to normal operation

9) Alarm Tests
   a) NOTE: These alarms have not been explicitly included in the written SOO. It is good practice to perform these alarm tests and have thus been included here.
   b) Supply Fan Failure Test (Note: Owner to determine whether or not AHU can be shut off)
      (i) Time: _________ Record the current supply fan command and current supply fan status.
          (a) Supply Fan Command: __________
          (b) Supply Fan Status: __________
      (ii) Time: _________ Turn off supply fan at disconnect. Command fan on at EMS.
      (iii) Time: _________ Supply fan failure alarm should sound. Record the time when the alarm sounds
      (iv) Clear all overrides and alarms to restore the unit to normal operation
   c) Supply Fan in Hand Test
      (i) Time: _________ Record the current supply fan command and current supply fan status.
          (a) Supply Fan Command: __________
          (b) Supply Fan Status: __________
      (ii) Time: _________ Operate the supply fan in hand. Command the fan off at EMS.
      (iii) Time: _________ Supply fan in hand alarm should sound. Record the time when the alarm sounds
      (iv) Clear all overrides and alarms to restore the unit to normal operation
   d) Supply Fan Runtime Exceeded Test
      (i) Time: _________ Record the current fan runtime and the current supply fan runtime limit.
          (a) Supply Fan Runtime: __________
          (b) Supply Fan Runtime Limit: __________
      (ii) Time: _________ Change the supply fan runtime limit below the current supply fan runtime and record value.
          (a) Supply Fan Runtime Limit: __________
      (iii) Time: _________ Supply fan runtime exceeded alarm should sound. Record the time when the alarm sounds
      (iv) Clear all overrides and alarms to restore the unit to normal operation
e) High Supply Air Temperature Test
   (i) Time: __________ Record the current supply air temperature alarm setpoint and current supply air temperature.
       (a) High Supply Air Temperature Alarm Setpoint: __________
       (b) Current Supply Air Temperature: __________
   (ii) Time: __________ Change the high supply air temperature alarm setpoint to 2°F below the current supply air temperature and record the value
       (a) High Supply Air Temperature Alarm Setpoint: __________
   (iii) Time: __________ Record the supply air temperature when the alarm sounds
       (a) Supply air Temperature: __________
   (iv) Time: __________ Record the new supply air temperature setpoint
       (a) Supply air Temperature Setpoint: __________
   (v) Clear all overrides and alarms to restore the unit to normal operation

f) Low Supply Air Temperature Test
   (i) Time: __________ Record the current supply air temperature alarm setpoint and current supply air temperature.
       (a) Low Supply Air Temperature Alarm Setpoint: __________
       (b) Current Supply Air Temperature: __________
   (ii) Time: __________ Change the low supply air temperature alarm setpoint to 2°F above the current supply air temperature and record the value
       (a) Low Supply Air Temperature Alarm Setpoint: __________
   (iii) Time: __________ Record the supply air temperature when the alarm sounds
       (a) Supply air Temperature: __________
   (iv) Time: __________ Record the new supply air temperature setpoint
       (a) Supply air Temperature Setpoint: __________
   (v) Clear all overrides and alarms to restore the unit to normal operation

g) High Return Air Temperature Test
   (i) Time: __________ Record the current return air temperature alarm setpoint and current return air temperature.
       (a) High Return Air Temperature Alarm Setpoint: __________
       (b) Current Return Air Temperature: __________
   (ii) Time: __________ Change the high return air temperature alarm setpoint to 2°F below the current return air temperature and record the value
       (a) High Return Air Temperature Alarm Setpoint: __________
(a) High Return Air Temperature Alarm Setpoint: _________

(iii) Time: _________ Record the return air temperature when the alarm sounds

(a) Return air Temperature: _________

(iv) Time: _________ Record the new return air temperature setpoint

(a) Return air Temperature Setpoint: _________

(v) Clear all overrides and alarms to restore the unit to normal operation

h) Low Return Air Temperature Test

(i) Time: _________ Record the current return air temperature alarm setpoint and current return air temperature.

(a) Low Return Air Temperature Alarm Setpoint: _________

(b) Current Return Air Temperature: ____________

(ii) Time: _________ Change the low return air temperature alarm setpoint to 2°F above the current return air temperature and record the value

(a) Low Return Air Temperature Alarm Setpoint: _________

(iii) Time: _________ Record the return air temperature when the alarm sounds

(a) Return air Temperature: _________

(iv) Time: _________ Record the new return air temperature setpoint

(a) Return air Temperature Setpoint: _________

(v) Clear all overrides and alarms to restore the unit to normal operation

i) High Mixed Air Temperature Test

(i) Time: _________ Record the current mixed air temperature alarm setpoint and current mixed air temperature.

(a) High Mixed Air Temperature Alarm Setpoint: _________

(b) Current Mixed Air Temperature: ____________

(ii) Time: _________ Change the high mixed air temperature alarm setpoint to 2°F below the current mixed air temperature and record the value

(a) High Mixed Air Temperature Alarm Setpoint: _________

(iii) Time: _________ Record the mixed air temperature when the alarm sounds

(a) Mixed air Temperature: _________

(iv) Time: _________ Record the new mixed air temperature setpoint

(a) Mixed air Temperature Setpoint: _________
(v) Clear all overrides and alarms to restore the unit to normal operation

j) Low Mixed Air Temperature Test
   (i) Time: __________ Record the current mixed air temperature alarm setpoint and current mixed air temperature.
       (a) Low Mixed Air Temperature Alarm Setpoint: __________
       (b) Current Mixed Air Temperature: __________
   (ii) Time: __________ Change the low mixed air temperature alarm setpoint to 2°F above the current mixed air temperature and record the value
       (a) Low Mixed Air Temperature Alarm Setpoint: __________
   (iii) Time: __________ Record the mixed air temperature when the alarm sounds
       (a) Mixed air Temperature: __________
   (iv) Time: __________ Record the new mixed air temperature setpoint
       (a) Mixed air Temperature Setpoint: __________
   (v) Clear all overrides and alarms to restore the unit to normal operation

k) High Building Pressure Test
   (i) Time: __________ Record the current building pressure alarm setpoint.
       (a) High Building Pressure Alarm Setpoint: __________
   (ii) Time: __________ Change the high building pressure alarm setpoint to 0.2 in. w.c. above the current building pressure setpoint and record the value

l) Low Building Pressure Test
   (i) Time: __________ Record the current building pressure alarm setpoint.
       (a) Low Building Pressure Alarm Setpoint: __________
   (ii) Time: __________ Change the low building pressure alarm setpoint to 0.2 in. w.c. below the current building pressure setpoint and record the value
       (a) Low Building Pressure Alarm Setpoint: __________

m) High Static Test
   (i) Time: __________ Record the current static pressure alarm setpoint.
       (a) High Static Alarm Setpoint: __________
   (ii) Time: __________ Change the high static alarm setpoint to 0.2 in. w.c. above the current static pressure setpoint and record the value
       (a) High Static Alarm Setpoint: __________
(iii) Time: __________ Override and increase the VFD speed in small increments (+5%) until the duct static pressure exceeds the alarm setpoint and the high static alarm sounds on the EMS

(iv) Time: __________ Record the static pressure when the alarm sounds

(a) Static Pressure: __________

(v) Time: __________ Record the new static pressure setpoint

(a) Static Pressure Setpoint: __________

(vi) Clear all overrides and alarms to restore the unit to normal operation

n) Low Static Test

(i) Time: __________ Record the current static pressure alarm setpoint.

(a) Low Static Alarm Setpoint: __________

(ii) Time: __________ Change the low static alarm setpoint to 0.2 in. w.c. below the current static pressure setpoint and record the value

(a) Low Static Alarm Setpoint: __________

(iii) Time: __________ Override and decrease the VFD speed in small increments (+5%) until the duct static pressure exceeds the alarm setpoint and the low static alarm sounds on the EMS

(iv) Time: __________ Record the static pressure when the alarm sounds

(a) Static Pressure: __________

(v) Time: __________ Record the new static pressure setpoint

(a) Static Pressure Setpoint: __________

(vi) Clear all overrides and alarms to restore the unit to normal operation

o) Freeze Protection

(i) Time: __________ Record the current temperature of the air entering the cooling coil, chilled water valve position and freeze protection setpoint

(a) Temp: __________

(b) CHWV: __________

(c) Freeze Protection Setpoint: __________

(ii) Time: __________ Override the temperature of the air entering the cooling coil to +0.5°F above the freeze protection setpoint

(iii) Time: __________ Begin lowering the temperature of the air entering the cooling coil by 0.5°F increments until the freeze protection sequence starts and the unit shuts down. The chill water valve should open to 100% and an alarm should display on the EMS

(iv) Record the temperature at which the sequence initiated.
p) Filter Change Required
   (i) Time: __________ Record the current filter differential pressure limit.
       (a) Filter differential pressure limit: __________
   (ii) Time: __________ Change the Filter differential pressure limit below the current differential pressure (say 0.2" w.c) and note.
       (a) Filter differential pressure limit: __________
   (iii) Time: __________ Filter change required alarm should sound. Record the time when the alarm sounds.
   (iv) Clear all overrides and alarms to restore the unit to normal operation

q) Supply Fan Fire Alarm Failure Test
   (i) Time: __________ Record the current supply fan command and current supply fan status.
       (a) Supply Fan Command: __________
       (b) Supply Fan Status: __________
   (ii) Time: __________ Issue a fire alarm signal at EMS.
   (iii) Time: __________ Supply fan failure alarm should sound. Record the time when the alarm sounds and Supply Fan shuts off.
   (iv) Clear all overrides and alarms to restore the unit to normal operation

10) Trend Review
    a) After completion of the trend period collect the trend data and review it for the following:
    b) Start/stop
       (i) The fan should run 24x7 throughout the trending period
    c) Fan Speed with static pressure setpoint adjustment
       (i) The fan VFDs should modulate to maintain the fixed static pressure setpoint
    d) Building Pressure Control
       (i) The building pressure differential varies as expected along with changes in supply duct static pressure
    e) Supply air temperature setpoint reset
       (i) The supply air temperature should reset based on reset table.
    f) Supply air temperature
(i) The supply air temperature should be maintained within ±2°F at all times

g) Chilled Water Valve
   (i) The chilled water valve should modulate to maintain the supply air temperature setpoint

h) Hot Water Valve
   (i) The hot water valve should modulate to maintain the supply air temperature setpoint and maintain low limit discharge air temperature

i) Simultaneous heating and cooling
   (i) At no time should both the hot water and chilled water valves be open

j) Alternating heating and cooling
   (i) The unit should not be rapidly alternating between heating and cooling

Final Test Results

□ Pass  □ Fail  Name: ___________________________________________  Date: __________________________

END OF TESTING PROCEDURE

END OF SECTION 15995
SECTION 16010

ELECTRICAL GENERAL PROVISIONS

PART 1 – GENERAL

1.01 Description

A. Description: The work under division 16 shall include all electrical work associated with the California State University Monterey Bay.

B. Approvals of Substitutions: Approval of alternative and/or substitute products will be considered only under the terms and conditions specified in Division 1 and the Contract General Conditions.

1.02 Quality Assurance

A. Codes and Regulations:

1. Ordinances and Regulations: All work shall comply with regulations of the State of California. State permits shall be obtained, fees paid and inspections made. Also conform to the rules and regulations of the State of California; Title 24 Building Standards Basic Electrical Regulations, NFPA, CBC.

1.03 Submittals

A. Material List Submittal: Submit a complete list of every specified material and equipment items, stating the manufacturer and catalog number for each item selected, within 30 days of Award of Contract.

B. Submittal Arrangement and Notations: Specification item lists, performance data and equipment drawings submitted shall be indexed and listed in sequential order by specification section and paragraph number. Submit complete data for each specifications section at one time. Incomplete data may cause a Section to not be accepted. Each submittal document shall be identified with the pertinent specification paragraph number. Each specification section shall be accompanied by a Section Index which shall list the specification paragraph number, item, equipment mark, manufacturer and model number and electrical characteristics where applicable.

C. Equipment Drawings and Performance Data: Submit the following data in addition to the data sheets submitted, suitable for subsequent use and inclusion in Maintenance Manuals.

1. Materials and Equipment on Which Such Drawings are Required:

   Switchboards
   Panelboard Equipment
   Motor Control Centers
   Fire Alarm System

2. Drawings: Include overall dimensions (height, widths and lengths); front elevations view shall be drawn to scale showing equipment arrangements and connection details; and elementary wiring diagrams. Drawings shall be sufficiently accurate and complete to permit layout and coordination of connections, and to show clearances required, so that possible interferences can be avoided. All drawings shall be generated on a CADD system compatible with Auto CADD.

3. Format: Accordion-fold to letter size; if prepared by a supplier, the Contractor shall check and approve and so stamp. prior to submittal. All submittals shall be identified by specification reference.

4. Additional submittal information is called for in subsequent technical specifications, and shall be
D. **Layout Drawings by the Contractor:** Prepare detail layout drawings to a larger scale than the Contract Drawings in areas where the work is of sufficient complexity to warrant additional detailing. This shall apply to all Mechanical and Electrical Rooms, elevator rooms, and in other areas where the work is of sufficient complexity to warrant additional detailing, and to electrical work at switchboards and motor control centers, and panelboard cabinets in Electrical Rooms. Prepare these drawings using Auto CADD on tracings the same size as the Contract Drawings and submit with each set of the Owner's record drawings. Submit all layout drawings for approval before commencing shop fabrication or field erection. Layout drawings shall conform to the foregoing requirements and as follows:

1. The equipment sizes shown shall be coordinated with the actual approved equipment, including required clearances.
2. Location and size of all equipment, sleeves, feeders conduits, support structures, bracing concrete pads, etc.
3. Routing of major conduits concealed in walls and ceiling spaces drawn to scale.
4. Location of HVAC ducts serving main electrical room coordinated with exposed feeder routings.
5. Code clearance around equipment per NEC and access space.
6. Changes in equipment locations proposed by the Contractor to suit job site conditions.
7. Layout drawings showing mounting height and position dimensions for all devices being installed under Division 16 for all Laboratories and typical offices.

E. **Project Closeout:** In addition to project closeout requirements specified in Division 1, submit to the Architect the following, prior to final system check-out.

1. Completed record drawings per Division 1 and 16.
2. Written notice of completion, certifying that work on each system has been completed per requirements of contract documents, all required testing is completed and that all systems and controls are operational.
3. Record Drawings: In addition to requirements in Division 1, include any detailed layout drawing prepared by the Contractor in record drawing information submittal to the Architect. Project record electrical drawings shall indicate accurate equipment device locations, circuiting and raceway routing for all Division 16 work. Maintain Record Drawings in accordance with Section 01700 and Contract General Conditions.

### 1.04 General Requirements

A. **Materials and Equipment:** The Contractor shall make certain that all materials and equipment selected by him or by his suppliers, conform exactly to requirements of the drawings and specifications. To whatever extent possible, all materials and equipment of a specific type or specification Section shall be of a single manufacturer. Transmittal of such specifications and drawing information to persons manufacturing and supplying materials to the project, and rigid adherence thereto, is the Contractor's responsibility. Approval of a manufacturer's name by the Owner does not release the Contractor of the responsibility for providing materials which comply in all details with requirements in the Contract Documents.

B. Examine and compare the Electrical Drawings and Specifications with the Drawings and Specifications of other trades, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid, the most stringent requirements must be included in said bid. Install and coordinate the electrical work in cooperation with other trades installing interrelated work.
Before installation, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor, caused by his neglect to do so, shall be made by him at his own expense.

C. Covered or Enclosed Work: The Contractor shall obtain inspection and approval from the Architect of any installation to be covered or enclosed prior to such closure.

D. Any changes required in the work of the Contractor, caused by his neglect to coordinate his work with others shall be made at his own expense.

E. Manufacturer's Installation Details: Follow wherever available. Provide special wiring or fittings called for by them.

F. These Specifications can out certain duties of the Electrical Subcontractor and his Subcontractors. They are not intended as a material list of items required by the Contract Documents.

G. This Division of the Specifications covers the electrical systems of the project. It includes work performed by the electrical trades, as well as trades not normally considered as electrical trades.

H. Provide all items and work indicated on the Drawings and all items and work called for in this Division of the Specifications in accordance with the Conditions of Contract. This includes all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor, consumable items, fees, licenses, etc. necessary to provide complete systems. Perform start-up and check-out on each item and system to provide fully operable systems.

I. Certain terms such as -shall, provide, install, complete, start-up- are not used in some parts of these Specifications. This does not indicate that the items shall be less than completely installed or that systems shall be less than complete.

J. It is the intent of the Drawings and Specifications to provide a complete workable systems ready for the Owner's operation. Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform with the intent, are to be considered a part of the Contract.

K. These Specifications are basically equipment and performance Specifications. Installations and details shall be as indicated on the Drawings. Where these differ from the Specifications, apply the more stringent at time of bid. Upon award of bid, contact Architect/Engineer for definite instructions.

L. All materials furnished by the Contractor shall be new and unused and free from defects. All materials used shall bear the Underwriters’ Laboratory, Inc. label, provided a standard has been established for the material in question.

M. All products and materials to be new, clean, free of defects and free of damage and corrosion.

N. No exclusion from, or limitation in, the symbolism used on the Drawings for electrical work of the languages used in the Specifications for electrical work shall be interpreted as a reason for omitting the accessories necessary to complete any required system or item of equipment.

O. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred.

P. Except for conduit, conduit fittings, out/et boxes, wire and cable, all items of like equipment or material shall be the product of one manufacturer throughout. Multiple manufacturers will not be permitted.

1.05 Coordination

A. Coordination of Trades: Compare the electrical drawings and electrical specifications with all of the drawings and
all of the specifications for the complete job and report any discrepancies to the Architect. Obtain from the Architect written instructions for changes necessary. The electrical work shall be installed in cooperation with other trades. Before installation, make provisions to avoid interferences.

B. Responsibility for Slots, Chases and Openings: Slots, chases and openings through floors, walls, ceilings and roofs as specified in new construction will be provided by the various trades, but the trade requiring them shall see that they are installed and properly located, and shall be responsible for any cutting and patching caused by their omission or improper location.

C. Anchor bolts, sleeves, inserts and supports that are required shall be furnished and installed under the same section of the specifications as the respective items to be anchored, with locations as directed by the trade requiring them.

D. Sprinkler Heads and Other Devices: Automatic sprinklers will be installed in certain areas. Check the locations selected for all sprinkler heads and check the Architectural reflected ceiling plans to prevent conflicts between the trades. In cases where an electric outlet or light fixture and a sprinkler head occupy the same position, the Architect will decide which shall be shifted.

E. Drilling and Cutting of Concrete: Drill all new openings through existing concrete with rotary diamond drill core-drilling equipment or carbide-tipped drills.

F. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.

G. Carefully check space requirements with other trades and the physical confines of the area to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings. Make modifications thereto as required.

H. Wherever work interconnects with work of other trades, coordinate with other trades to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all items of work that require access so that the ceiling trade will know where to install access doors and panels.

I. Consult with other trades regarding equipment so that motor controls are of the same manufacture.

J. The locations of lighting fixtures, outlets, panels and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in order to meet field conditions or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.

K. Exercise particular caution with reference to the location of panels, outlets, switches, etc., and have precise and definite locations approved by the Architect/Engineer before proceeding with the installation.

L. The Drawings show only the general run of raceways and approximate location of outlets. Any significant changes in location of outlets, cabinets, etc. necessary in order to meet field conditions shall be brought to the immediate attention of the Architect/Engineer and receive his approval before such alterations are made. All such modifications shall be made without additional cost to the Owner.

M. Obtain from the Architect/Engineer in the field the location of such outlets or equipment not definitely located on the Drawings.

N. Circuit “tags” in the form of arrows are used where shown to indicate the homeruns of raceways to electrical distribution points. These tags show the circuits in each homerun and the panel designation. Show the actual circuit numbers on the finished record tracing and on panel directory card. Where circuiting is not indicated, Electrical Subcontractor must provide required circuiting in accordance with the loading indicated on the Drawings and/or as directed.
O. Where the Drawings do not indicate the exact number of wires in each conduit for the branch circuit wiring of fixtures and outlets, or the actual circuiting, provide the correct wire size and quantity as required by the indicated circuiting and/or circuit number indicated, control wiring diagrams, specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.

P. Adjust location of conduits, panels, equipment, pullboxes, fixtures, etc. to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each raceway and bus duct prior to fabrication.

1. Right-of-Way: Lines which pitch to have the right-of-way over those which do not pitch. For example: Steam, condensate, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed to have right-of-way over lines whose elevations can be changed.

2. Make offsets, transitions and changes in direction in raceways and bus duct and as required to maintain proper headroom in pitch of sloping lines whether or not indicated on the Drawings.

Q. Contractor shall furnish services of an experienced Superintendent who shall be in constant charge of all work, and who shall coordinate his work with the work of other trades. No work shall be installed before coordinating with other trades.

1.06 Drawings

A. General: The electrical drawings show the general arrangement of raceways, equipment and appurtenances, and shall be followed as closely as actual building construction and the work of other trades permit. The electrical work shall conform to the requirements shown on all of the drawings. Because of their small scale, electrical drawings are diagrammatic and do not show all offsets, fittings and accessories which may be required. Investigate the structural and finish conditions affecting the work and arrange the work accordingly. Provide fittings and accessories as may be required to fit job conditions.

1.07 Abbreviations

ANSI  American National Standards Institute.
As directed  As directed by the Architect.
As shown  As shown on the Drawings.
Concealed  Built into the construction and not exposed to view.
galv.  Galvanized.
Hz  Hertz.
Hot dip galv.  Galvanized after fabrication by not dip process.
mfr.  Manufacture, manufacturer.
NEC  National Electrical Code.
NEMA  National Electrical Manufacturers Association.
Per  According to, in accordance with.
PVC  Polyvinyl Chloride.
Provide  Furnish and install.
UL  Underwriters Laboratories, Inc
1.08 Maintenance Manuals

A. Scope: Provide preliminary review copy and multiple finished copies of electrical information for Maintenance Manuals for work under the project.

B. Time of submittal, and quantity of copies for preliminary and final submittal. Binding and other requirements shall be as specified in Division 1.

C. Binding: Self-expanding "Catalog Binder" with black simulated leather stiff board cover, hinged leaves, slide lock and metal posts, Boorum & Pease No. C-619-3 or equal. Cover shall be imprinted with name of trade or system (electrical etc.), name of job, Owner, Architect, Engineer and year of completion; spine imprinted with name of trade or system (electrical etc.), name of job, Owner and year of completion.

D. Equipment described shall include all items under Equipment Drawings and Performance Data, and also the following:
   - Switchboards
   - Panelboard Equipment
   - Lighting Control Materials
   - Disconnect Switches
   - Dry Type Transformers - 480 Volt Primary
   - Coordination of Electrical Systems Fault Protection
   - Lighting Fixtures
   - Fire Alarm and Life Safety Emergency System
   - Fire Fighters Communication System
   - Motor Controls

E. Contents of Manuals: Include catalog data; supplementary drawings where necessary to itemize servicing and maintenance points; all maintenance instructions and parts lists furnished by the manufacturer; tabulations describing the general type of equipment, frequency of service, type of service, diagrams of control systems. Omit non-applicable data.

F. Format: 8-1/2" x 11" size, neat, clean copies, drawings, accordion-folded. The manuals shall have a typewritten index and divider sheets with identification tabs between categories.

G. Manual Covers and Title Pages: In addition to the information required per Division 1, include the name of the Architect and Electrical Consulting Engineers on Maintenance Manual cover and names and addresses of the Architect and Engineers on the title page.

1.09 Materials Storage

A. Storage facilities for materials to be incorporated in the work shall be suitable to prevent any damage from corrosion or exposure, to the elements. Coordinate work space and storage with requirements in Division 1.

1.10 Instruction of Owner’s Representative

A. General: After installation, but before acceptance of electrical work, the Contractor shall conduct demonstration and instruction period to explain and point out servicing and maintenance requirements to the Owner’s representatives. Duration of instruction period shall be for five days, conducted by a superintendent or foreman acquainted with the work of the electrical trades. Arrange date and time with Owner and Architect with 7 days advance notice.

1.11 Examination of Site

A. Prior to the submitting of bids, the Contractor shall visit the site of the job and shall familiarize himself with all
conditions affecting the proposed installation and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph will in no way relieve the Contractor of performing all necessary work shown on the Drawings.

1.12 Progress of Work

A. The Contractor shall order the progress of his work so as to conform to the progress of the work of other trades and shall complete the entire installation as soon as the conditions of the building will permit. Any cost resulting from the defective or ill-timed work performed under this Section shall be borne by the Contractor.

1.13 Equipment Accessories

A. Establish sizes and location of the various concrete bases required. Coordinate with General Contractor and provide all necessary anchor bolts together with templates for holding these bolts in position.

B. Provide supports, hangers and auxiliary structural members required for support of the work.

C. Furnish and set all sleeves for passage of raceways through structural, masonry and concrete walls and floors and elsewhere as will be required for the proper protection of each raceway and bus duct and passing through building surfaces.

D. Wall mounted equipment may be directly secured to wall by means of steel bolts. Maintain at least 1” air space between equipment and supporting wall. Groups or arrays of equipment may be mounted on, adequately sized steel angles, channels or bars. Prefabricated steel channels providing a high degree of mounting flexibility such as those manufactured by Kindorf, Globe-Strutt and Unistrut, may be used for mounting arrays of equipment.

PART 2 – PRODUCTS
SEE SUBSEQUENT SECTIONS FOR MATERIALS.

PART 3 – EXECUTION

3.01 Installation

A. Installation and Arrangement: Install all electrical work to permit removal, without damage, of all parts requiring periodic replacement or maintenance. Arrange raceways, wiring and equipment to permit ready access to switches, motors and control components. Doors and access panels shall be kept clear.

B. Locations of equipment, fixtures, panels, etc., shall be adjusted to accommodate the work and to avoid interferences anticipated or encountered.

1. Right-of-Way: Lines which pitch shall have the right-of-way over conduit and EMT raceways. Lines whose elevations cannot be changed shall have the right-of-way over conduit and EMT raceways whose elevations can be changed.

2. Offsets and changes in direction of raceways shall be made as required to maintain proper headroom and clearances whether or not indicated on the Drawings. Provide all fittings, junction boxes, connectors, etc., as required to effect these offsets and changes in direction.

C. Manufacturers’ Installation Details: Conform to manufacturers’ instructions. Provide any fittings, disconnects, equipment connections, etc., recommended by manufacturer and per code as part of this Contract.

D. Ferrous metal work exposed to the weather, other than cast iron, shall be hot dip galvanized.

E. Nameplates: Provide, for equipment specified hereinafter. Shall be laminated black and white plastic with lettering cut through to white background. Submit list to the Architect for prior approval.
F. Entries and Corridor Areas: Obtain approval by the Architect of the location of all equipment and materials before final installation of work in these areas.

3.02 Mounting Heights
A. Mounting heights shall be as indicated on the Drawings or in these Specifications. Verify mounting heights with Architectural Interior Elevation Drawings.

3.03 cleaning Up
A. Contractor shall take care to avoid accumulation of debris, boxes, crates, etc., resulting from the installation of his work. Contractor shall remove from the premises each day all debris, boxes, etc., and keep the premises clean, subject to the Architect/Engineer's instructions, which shall be promptly carried out.

B. All switchboards, panelboards, wireways, cabinets, enclosures, etc. shall be thoroughly vacuumed clean prior to energizing the equipment and at the completion of the project. Equipment shall be opened for observation by the Architect as required.

3.04 Tests
A. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications. Tests shall be performed in the presence of the Architect and shall include, but are not limited to, the following:

1. Insulation Resistance: Perform 2500 volt DC tests for one minute on all equipment rated 300 volts and higher, feeder and branch circuit conductors, including the neutral, and make a typed record of all readings to be included in the maintenance instructions. Repair or replace circuits showing less than 10 megohms resistance to ground.

2. Circuit Continuity: Test all feeder and branch circuits for continuity. Test all neutrals for improper grounds.

3. Equipment Operation: Test motors for correct operation and rotation. Test lighting circuits for correct operation through their control devices.

4. Lighting Control Circuits: Perform operation tests for all lighting circuits.

5. Alarm and Interlock Systems: Produce malfunction symptoms in operating systems to test alarm and interlock systems. All smoke detectors shall be activated to verify proper zone annunciation and alarm signal interlocks. Activation of smoke detectors, both ceiling and duct type, shall be accomplished by means of a smoke emitting device per manufacturer's recommendation. Correct operation of alarm circuit annunciation in the exterior fire alarm zone annunciation panel shall be verified. See separate Section for fire alarm.

6. Circuit Numbering Verification: Select on a random basis, various circuit breakers in the panelboards and cycle them on and off to verify compliance of the typed panel directories with actual field Wiring.

B. Product Failure: Any products which fail during the tests or are ruled unsatisfactory by the Architect shall be replaced, repaired or corrected as prescribed by the Architect at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.

C. Miscellaneous: Include all test results in the Maintenance Manual. Cost, if any, for all tests shall be paid by the Contractor.

D. Test Procedures and Reports: The Contractor shall notify the Owner's representative in writing at least 48 hours before each system test, for mechanical work. The Owner will contract for and pay for all selected testing. Monitor
all tests. A written report shall be prepared by the Contractor and submitted to the Owner's representative showing the following as a minimum:

1. Who conducted test.
2. Test plan, i.e., times, voltages, amperes, etc.
3. Test results, i.e., times, pressures, a part of system that failed to meet test minimum and why. Corrective action recommended.
4. Names and titles of state inspectors present.

### 3.05 Construction Component (cc) Testing

A. Equipment component and certain operational system testing, designated as Construction Component (CC) Tests, shall be performed by the Contractor in accordance with the following procedures.

B. CC Testing Shall Include:

1. Continuity megger, and high potential measurements.
2. Selector switches shall be checked and manually operated.
3. Insure shipping blocks and tie-downs have been removed.
4. Initial load readings for the power system may also be required.
5. Check operability of all controls, interlocks, etc.
6. Verification of factory representative instructions for the Operating Contractor's personnel.
7. Voltage check of all switchgear on which work is being done, at no load and full load, phase to phase and phase to neutral.
8. Phase sequence shall be checked, as well as proper identification and color coding. Coordinate phase sequence between utility and generators.
9. Indicating and recording instruments and selector switches shall be checked at low, mid and high end of their range.
10. Equipment, devices shall be checked for workmanship and general appearance. Any external factors such as moisture, chemicals, dust and oil that are detrimental to the equipment shall be noted and corrected.
11. All electrical equipment shall be checked for missing or loose parts. Doors and latches shall be checked for proper fit.

C. Instruments for CC Testing:

1. Test instruments shall have an accuracy of 1/2 of 1% for voltmeters, 2% for clip-on ammeters, 2% for meggers.
   a. All instruments shall be accurately calibrated by an approved testing laboratory before use. Submit calibration record to Engineer before use.

### 3.06 System Operation (SO) Testing

A. The Contractor is responsible for the final overall system testing to verify conformance to the specification and
drawing requirements for operation and are designated as SO Tests. Test procedures and durations shall be as
designated by the Engineer. All tests shall be witnessed by the Contracting Officer.

B. SO test procedures shall cover the complete operation of each system and shall include not only the determination
that the system operating characteristics are as designated, but shall be used to complete the Equipment/Component
Testing, if required.

1. Final calibration, settings, sequencing and functional control of all instruments, loops and control
   systems.

2. Calibration of protection relays; load testing. Demonstration of operation of meters.

C. Operation of building systems which furnish loads to the switchgear and metering cabinets will be by the system
   supplier. Operation of Contractor-furnished equipment shall be by the Contractor.

D. Final Work Item: Contractor shall tighten all feeder connections in the presence of a representative of the
   Architect.

END OF SECTION
SECTION 16020
CORING, SLEEVING AND SEALING – ELECTRICAL WORK

PART 1 – GENERAL

1.01 Description
A. Description: Work specified in this Section includes coring, sleeving and sealing of electrical penetrations. In addition, work includes coordinating sizes and placement of blockouts for openings in concrete slabs and walls.
B. Approvals of Substitutions: Approval of alternative and/or substitute products will be considered only under terms and conditions specified in Division 1.

1.02 Quality Assurance
A. Codes and Regulations:
   1. General: Per requirements in Section 16010.

1.03 Submittals
A. Product Data: Per requirements in Section 16010.

1.04 Work In Other Sections
A. Firestopping and Smokestopping Seals: Refer to Division 7 for firestopping and smokestopping of electrical penetrations (e.g. raceways, cable, tubing, conduit and wiring) through floor slabs and through time-rated partitions, ceilings, fire and smoke walls. This work is not described in Section 16020, but is required as part of the Electrical work.
B. Electrical Penetrations Through Wallboard: Refer to Division 9.

PART 2 – PRODUCTS

2.01 Materials
A. Sleeves:
   2. Sheetmetal Sleeve: 18 gauge galvanized sheetmetal.
   4. Riser Sleeve: Josam No. 26240 or equal of Jay R. Smith or Zurn manufacturer; threaded each end for pipe sleeve extension; anchor lugs, flashing flange and flashing clamp ring.
B. Waterproof Seal:
   1. Segmented Rubber Seal: Multiple segmented bolted neoprene rubber element interlinked and clamped in place by bolting; Thunderline "Link Seal."
   2. Rope Packing: Polystyrene rope packing.
C. Acoustical Seals:
   2. Foam and Fiber Packing Sealant: Dow Corning "Fire Stop Foam" Catalog No. 2001 two component silicone elastomeric foam used with U.S. Gypsum Thermafiber packing.

D. Vermin-Resistant Seals:
   1. Rope Packing: Polystyrene or other plastic rope or cord type packing.
   3. Silicone Sealant: White colored silicone sealant by Dow or General Electric manufacturer.

PART 3 – EXECUTION

3.01 Sleeves

A. General:
   1. Provide sheetmetal or steel pipe sleeves at electrical penetrations through concrete or masonry slabs, walls, floors and roofs; plastic sleeves allowed only in non-fire or non-smoke rated construction. In general, electrical penetrations through wallboard will be built-in by the wallboard installer. Coordinate with Division 9 to obtain properly prepared wallboard openings.
   2. Sleeves for Waterproof Seals: Sleeves shall be galvanized steel pipe with embedding lugs welded on.
   3. Sleeves for Electrical Penetrations Through Floor Slabs and Through Time-Rated Partitions, Ceilings, Fire Walls and Smoke Walls: Sleeves shall be of the same material and thickness as was used when the firestop material was tested in accordance with ASTM E814 or ANSI/UL 1497. Coordinate with Division 7 for fire stop material being used.
   4. Sleeves For Acoustical Seals: Provide sheet metal sleeves. Sleeves for gypsum wallboard acoustical walls shall be plastered to the wall to ensure an airtight seal. Where double walls are penetrated, a separate sleeve shall be cut and fit to each side of the wall; allow no sleeve connection between walls.
   5. Sleeves for Conduit Roof Penetrations: Provide flanged, Schedule 40 pipe sleeve anchored to slab and projecting above roof at least 12”.
   6. Floor Slab Sleeves, Projecting: (Mechanical, Data/Communications, Electrical and Fan Rooms with floor slabs above grade): Galvanized steel pipe sleeve cast-in-concrete; sleeves extended 1" above finished floor surface.
   7. Floor Slab Sleeves, Isolating Floor Slab: Oversize steel pipe sleeve through structural slab; riser sleeve cast in isolating slab with steel pipe nipple threaded into riser sleeve; resilient packing around pipe in riser sleeve.
   8. Sleeve for Moisture-Proof Membranes: Riser sleeve cast-in-concrete, with clamping ring and with galvanized steel pipe nipple extending through the slab.
   9. Sleeve Lengths: All sleeves shall pass through the entire thickness of walls, partitions and slabs.

B. Coring:
1. Core-Drilled Holes Through Concrete: Shall be made with diamond or carbide surfaced drilling equipment, not by jackhammer. Coordinate with Structural Drawings and locate all such openings to avoid cutting of major reinforcing bars. Do not core-drill any pre-cast concrete.

C. Sleeve or Coring Dimensions:

1. Non-Sealed Sleeve or Cored Opening: Maintain 1/4” annular space between the sleeve or cored opening and the electrical penetration.

2. Sleeve or Cored Opening for Waterproof Seals: For segmented rubber seals, provide annular space as required by manufacturer's installation recommendations. For seals for moisture-proof membranes, provide 1/2” annular space.

3. Sleeve or Cored Opening for Acoustical Seals: 1/2” annular space between sleeve or cored opening and the electrical penetration.

4. Sleeve or Cored Opening for Electrical Penetrations Through Floor Slabs and Through Time-Rated Partitions, Ceilings, Fire Walls and Smoke Walls: The annular space between the sleeve or cored opening and the surfaces of raceways, cables, tubing, conduit or wiring shall be the same dimensions as the annular space used when the firestop material was tested in accordance with ASTM E814 or ANSI/UL 1479. Coordinate with Division 7 for firestop material being used.

5. Sleeve for Conduit Roof Penetrations: 1/2” annular space between sleeve and conduit.

3.02 Rectangular Blockouts

A. Rectangular blockouts shall be built as part of the formwork for the concrete work.

B. Prepare schedules for openings required for work of electrical trade, prior to time the formwork is fabricated, and deliver all such size information to the Architect.

C. Sizes of openings shall be matched closely to actual net dimensions required.

3.03 Waterproof Seals

A. Waterproof Seals For Conduit Through Walls Below Grade: Conduit shall be installed concentrically through the sleeve. Provide a segmented rubber seal around the conduit through the sleeve, and install to be watertight.

B. Waterproof Seals for Conduit Through Moisture-Proof Membranes: Extend conduit through sleeve. Pack annular space with rope packing and fill with mastic sealant.

C. Sealing and Flashing for Conduit Penetrations Through Roof: Provide six-pound-per-cubic-foot sheet lead plumbing vent flashing interlaminated with the roofing outside of the projecting sleeve and turned down over projecting sleeve at least 1-1/2”. Provide funnel-shaped 16 gauge galvanized sheetmetal counterflashing sealed watertight with mastic sealant to conduit and tightly clamped with stainless band clamp to conduit and extending down over projecting sleeve with at least 2” overlap.

3.04 Acoustical Seals

A. Acoustical Seals for Electrical Penetrations:

1. Electrical Penetrations Through Gypsum Wallboard Acoustical Walls: The annular space between the electrical penetrations and the sleeve shall be packed with fiber packing and sealed with foam sealant.

2. Electrical Penetrations Through Gypsum Wallboard Acoustical Ceilings: Penetrations shall be sealed airtight with resilient acoustical caulk sealant.
3. Electrical Penetrations Through Concrete and Masonry Acoustical Walls and Floors: Penetrations shall be sealed the same as for gypsum wallboard walls except that sheetmetal sleeves shall not be required.

END OF SECTION
SECTION 16040

FIRE/SMOKE STOPS

PART 1 – GENERAL

1.01 Related Documents
   A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.02 System Description
   A. Fire/smoke stops in time-rated walls and floors for cable, cable tray, and conduits, per UL and Code requirements.
   B. System shall readily permit changes and additions to systems after completion.

1.03 Submittals
   A. Submit shop drawings and product data in accordance with Division 1.

PART 2 – PRODUCTS

2.01 Acceptable Manufacturers
   A. Acceptable Manufacturers:
      1. General Electric Co., PENSIL #851
      2. Chase Technologies, Chase Foam #CTC-PR-855.
      3. 3M Co., #CP-25 caulk; #303 putty; #FS-195 wrap/strip; #CS-195 composite sheet.
      5. Wiremold - Flamestopper.
      6. STI- Mechanical System.
   B. Accessories and other components as required to complete installation.

PART 3 – EXECUTION

3.01 Installation
   A. Follow manufacturer's recommended procedures to provide cold-smoke and/or fire stops in time-rated walls and floors.
   B. Demonstrate to Owner installation procedures for changes and additions to the systems.

END OF SECTION
SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.01 Related Documents

A. Drawings, Construction Services Agreement, including General and Special Conditions and Division-1 Specification Sections, apply to work specified in this Section.

1.02 Work Included

A. Work Included in This Section: Materials, equipment fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction, for the following

1. Raceways.
2. Wire and cable.
3. Low voltage distribution equipment.
5. Disconnect switches.
6. Devices.
7. Inserts and supports.
8. Telephone conduit system.
9. Cutting and patching.
10. Excavation and backfill.
11. Outlet boxes.
12. Pull and junction boxes.

B. Related Work in Other Sections:

1. Temporary light and power, Division 1.
2. Finished painting, specified elsewhere.
3. Furnishing and setting of motors under the sections corresponding to equipment that have motors.
4. Furnishing and installing access doors in finished surfaces, Division 8.
5. Cutting, Division 1.
7. Patching, Division 1.
8. Concrete, Division 3.
9. Commissioning, Division 1
10. Commissioning, Section 16970

C. Definitions: Specifications are of a simplified form and include incomplete sentences. Words such as "shall be", "furnish", "a", "an", "the", etc., have been omitted for brevity.

1. "Furnish" or "Provide": To supply, install and connect up complete and ready for safe and regular operation of particular work referred to unless specifically otherwise noted.
2. "Install": To erect, mount and connect complete with related accessories.
3. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
4. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
5. "Wiring": Raceway, fittings, wire, boxes and related items.
6. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
7. "Exposed": Not installed under ground or "concealed" as defined above.
8. "Indicated", "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.
9. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design and efficiency of specified product, conforming with "Sase Sid Manufacturers".
10. "Reviewed", "Satisfactory", "Accepted" or "Directed": As reviewed, satisfactory, accepted or directed by or to Architect.

1.03 Incorporated Documents

A. Requirements of General Conditions and Division 1 apply to all work in this Section.

B. Published specifications, standards, tests or recommended methods of trade, industry or governmental organizations apply to work of this Section where cited below:

1. AEIC - Association of Edison Illuminating Companies.
2. ASTM - American Society of Testing Materials
3. IEEE - Institute of Electrical and Electronic Engineers
4. NEMA - National Electrical Manufacturers’ Association
5. NFPA - National Fire Protection Association
6. State of California, CAL OSHA.
7. State of California, California Code of Regulations.
1.04 QUALITY ASSURANCE

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

B. Supply all equipment and accessories new, free from defects and listed by Underwriters' Laboratories, Inc., or bearing its label.

C. Supply all equipment and accessories in compliance with the applicable standards listed in this Section and with all applicable national, state and local codes.

D. All items of a given type shall be the products of the same manufacturer.

1.05 SUBMITTALS

Submit in accordance with the requirements of Section 16010 the following items:

A. A list of conduit types indicating where each type of conduit will be used. Indicate conduit manufacturers and fittings to be used.

B. Wires and cables.

C. Pullboxes: Include scaled and dimensioned drawings for all boxes over 64 cubic inches.

D. Terminal cabinets.

E. Switches and receptacles. Submittal data shall clearly indicate UL and NEMA compliance.

F. Device plates, including engraving schedules where engraved plates are specified.

G. Motor starters, including thermal overload relay and thermal trip data and control wiring diagrams.

H. Disconnect switches.

I. Panelboards including scaled layout of electrical rooms showing equipment and required clearances.

J. Overcurrent protective device, submittals including circuit breaker trip characteristic curves and fuse current let-through and melting time charts.

K. Satisfy seismic requirements for the State of California.

L. Drawings pertinent to deviations from the Contract. Coordinate with other trades and field conditions and show dimensions and details including building construction and access for servicing.

M. Detailed description of items supplied, including specifications, performance characteristics, materials, wiring diagrams and schedules.

N. Evidence of compliance with the applicable standards listed under Article 1.03 of this Section.

O. List of manufacturer’s recommended spare parts and address of nearest representative.

1.06 Product Delivery, Storage and Handling

A. Equipment shall be shipped in its original packages to prevent damage or entrance of foreign matter. All handling and shipping shall be performed in accordance with manufacturer’s recommendations. Provide protective coverings during construction.
B. Replace, at no expense to Owner, equipment or material damaged during storage or handling, as directed by the Architect.

C. All items shall be tagged with a weatherproof tag identifying equipment by name and purchase order number. Packing and shipping lists shall be included.

PART 2 – PRODUCTS

2.01 Raceways

A. Raceways: Complete with boxes, fittings and accessories.

B. Raceways:

1. **Rigid Steel Conduit**: Full weight pipe, galvanized, threaded, minimum diameter 3/4", except as noted or required for wiring.

2. **Intermediate Metal Conduit (IMC)**: Hot dip galvanized steel meeting the requirements of CEC Article 345 and conforming to UL Standard 1242.

3. **Electrical Metallic Tubing (EMT)**: Thin wall pipe, galvanized, threadless, minimum diameter 3/4", except as noted or required for wiring.

4. **Flexible Steel Conduit**: Continuous single strip, galvanized, minimum diameter 3/4" as noted or required for wiring. PVC covered for liquid tight.

5. **Wireways**: Complete with all fittings and accessories. Size as noted, baked enamel finish inside and outside, approved for support at minimum 10’ on centers.

   a. **Interior Use**: Hinged cover and base, minimum thickness 16 gauge galvanized steel.


6. **Metal Clad (MC) Cable**: Metal-clad Cable (Type MC) may only be used to concealed branch circuits in areas listed in 16050-3.03-N. Description: CEC, Type MC. Manufactured in accordance to NEC Article 334. AFC Type MC-Lite or equivalent. Conductor: Coper. Insulation voltage rating: 600 volts. Insulation temperature rating: 90 degrees C. Insulation and armor material: aluminum. Armor design: interlocked metal tape, corrugated tube or smooth tube. Ground: internal insulated green copper conductor.

C. **Fittings and Accessories**:

1. **Raceway Fittings**:

   a. **Rigid Conduit**: Steel or malleable iron, galvanized. Zinc die cast fittings not permitted.

   b. **IMC Fittings**: Conduit couplings, connector and bushing shall be as specified for rigid steel conduit.

   c. **EMT**: Set screw type, insulated throat. Compression type for outdoors and damp locations, for service taps or feeds to multimeter switchboards.

   d. **Flexible Metallic Conduit**: clamp type utilizing one set screw 3/8" thru 1", 2 set screws 1 1/4" and larger, insulated throat. O.z. Gedney, KC Series, or equal.

   e. **Bushings**: Metallic insulated type. Weatherproof or dust-tight installations; liquid-tight with sealing ring and insulated throat.
2. Sleeves

a. Exterior Non-Membrane Waterproofed Walls: Galvanized cast iron, galvanized steel or wrought iron with continuously welded center flange.

b. Exterior Membrane Waterproof Walls, Floors and Roofs: Galvanized cast iron, flashing flange and clamping ring. Similar to Josam 1870 series or as required by construction.

c. Exterior Non-Membrane Waterproof Roofs: Galvanized cast iron, flashing flange and clamping ring. Similar to Josam 1830 series or as required by construction.


e. Extend flashing 10" around edge of raceway. Flashing subject to review.

3. Seals: Raceways in sleeves, OZ/Gedney type WSR on both entries. Raceways through drilled or precast holes, OZ/Gedney type CSM at both entries. Cables in raceways, OZ/Gedney type CSB.

4. Concrete Markers: Cylindrical concrete column with embedded, marked bronze plate indicating direction of underground raceways at bends and terminations.

5. Acceptable Manufacturer for Fittings and Accessories: Similar to T&B/Thomas & Betts, Midland-Ross Corp, OZ/Gedney.

D. Boxes:

1. Outlet Boxes: Except as otherwise required by construction, devices or wiring, as follows:

a. Stamped Steel: 4" square or octagon for lighting fixtures; 1-1/2" deep above ceiling, 3" deep in slab, and 2-1/8" deep in wall.

b. In Wall For Receptacles and Switches: 4" square, 1-1/2" deep with raised covers and fixture studs where required. Through-the-wall type not permitted. 23/4" deep for data/communication outlets.

c. Galvanized Cast Iron or Aluminum With Threaded Hubs: 4" round, 2" deep on ceiling, and 4" square, 2" deep on wall.

d. Boxes For Outdoors and Damp Locations: Weatherproof.

e. Boxes Without Fixture or Device: Provide with blank cover.

f. Offset back-to-back outlets with minimum 18" separation, 24" at fire rated walls.

2. Junction and Pull Boxes:

a. Galvanized sheet steel.

b. Covers: Screw-on, except as noted.

c. With insulated supports for cables.

d. Locations: As indicated, where required and accessible. In all conduit runs after each three 90 degree bends.
2.02 600 Volt and Wire Cable

A. 600 Volt Wire and Cable, Complete With Accessories: Sizes AWG, except as noted.

B. Conductors:
   1. Solid copper for sizes No. 10 and smaller and stranded copper for sizes NO.8 and larger.
   2. For feeder conductors 100A and larger copper or aluminum. For aluminum, Alcan Stabalor (only) is acceptable. Install using compression terminations and all manufacturer installation recommendations and requirements.
   3. For General Uses: Minimum size No. 12. At 120 volts and over 100’ circuit length, minimum size No. 10. At 277 volts and over 220’ circuit length, minimum size No. 10.
   5. Increase raceway sizes as required for larger wires, as indicated, and for ground wires called for, but not shown.

C. Insulation:
   1. 600 Volt Insulation Types:
      a. Type THWNITHHN for wire sizes NO.8 and smaller and for wire sizes NO.6 and larger, except type THWN used in raceways located in concrete in direct contact with the earth, in raceways direct-buried in earth and in raceways in permanently wet locations.
      b. Color Coding for Phase Conductors, Respectively: A, B, Cblack, red, blue for 120/208 volt system and brown, orange, yellow for 277/480 volt system. Neutral (120V): white; Neutral (277V): grey; Ground: green.

D. Accessories:
   1. Cable Supports in Risers: Clamping device with insulation wedges or "Kellem" grips.
   2. Tags:
      a. Flameproof linen or fiber in accessible locations.
      b. Feeders: Indicate number, size, phase and points or origin and termination. Control or Alarm: Indicate type of controls or alarm and points of origin and terminations at all termination points.
   3. Terminations, Splices and Taps:
      a. Copper Conductors No. 10 and Smaller: Compression type or twist-on spring loaded connectors and clear nylon insulated covering.
b. Copper Conductors No.8 and Larger: Mechanical bolted pressure or hydraulic compression type, using manufacturer's recommended tooling.

c. Cable Lugs and Connectors: Compression type of same metal as conductor to match cables with marking indicating size and type.

d. For copper lug connections to bus bars, provide anti-seize compound.

e. Manufacturer: General Cable, Anaconda, Cyprus or approved equal.

2.03 Low Voltage distribution Equipment

A. Disconnect Switches:

1. Non-fused or fused as indicated.

2. Voltage: 250 volts rated on 120/208 volt circuits; and 600 volts rated on 277/480 volt circuits.

3. Heavy duty, quick-make/quick-break.

4. Horsepower rated for motor loads.

5. Toggle Type Switches as Follows:

a. Non-fused, load break.

b. Maximum Ratings: 20 amp at 600 volts, and 30 amp at 250 volts.

c. Two Pole: Similar to G.E. #TC2228.

d. Three Pole: Similar to G.E. #TC2368.

6. Knife Blade Type Switches:

a. Load break type with arc quenchers.

b. Maximum Rating: 800 amp at 600 volts.

c. Manufacturer: Similar to Square DQMB.

7. Pressure Type:


b. Stored energy, charge before close action and incapable of "teasing" switch on opening or closing.

c. Minimum Interrupting Capacity: 200,000 AIC.

d. Continuous Current Rating: As noted.

e. Renewable auxiliary arcing contacts, carriers and arc chutes.

f. Required for all switches 1,000 amps or greater.

g. Manufacturer: Similar to Pringle, type "CBC".

B. Fuses - Continuous Current Rating, As Indicated:
1. Dual Element/Current Limiting. Use for All Motor Circuits:
   a. Time delay.
   b. 200,000 amp I.C.
   c. Similar to Bussman, Type as Indicated:
      (1) Fusetron, "FRN", 250 volt, 15-600 amp (UL Class RK5).
      (2) Fusetron, "FRS", 600 volt, 15-600 amp (UL Class RK5).
      (3) Lo-Peak, "LPN", 250 volt, 15-600 amp (UL Class RK1).
      (4) Lo-Peak, "LPS", 600 volt, 15-600 amp (UL Class RK1).

2. Current Limiting. Use for Feeder Circuits:
   a. Time delay.
   b. 200,000 amp I.C.
   c. Similar to Bussman, Type as Indicated:
      (1) Hi-Cap, "KRP", 600 volt, 601-5000 amp (UL Class L).
      (2) Limitron, "KTN", 600 volt, 15-600 amp (UL Class RK1).
      (3) Limitron, "KTS", 600 volt, 15-600 amp (UL Class RK1).
      (4) Limitron, "KLU", 600 volt, 601-2000 amp (UL Class L).

3. All Fuses: Same manufacturer.

4. Provide one spare matching fuse for each set of three.

C. Circuit Breakers:

1. Molded Case:
   a. Thermal-magnetic, 400 amp frame and below; solid state, 600 amp frame and above. Bolt-on, quick-make/quick-break for both types.
   b. Manually operated with insulated trip-free handle and rated for switching duty.
   c. Multi-Pole Types: With internal trip bar.
   d. Terminals: Suitable for copper or aluminum cable.
   e. Auxiliary devices as indicated.
   f. Enclosures: Dead front, NEMA Type I, except as noted.
   g. Frames as indicated, interchangeable trips and interrupting capacity not less than noted and/or available symmetrical short circuit current.
   h. Manufacturer: Similar to Square D, Westinghouse "AB De-ion" and "Seltronic", G.E.
D. Panelboards - Circuit Breaker Type, Rating As Noted:

1. Bus Bars: Hard drawn copper, minimum 98% conductivity silver or tin plated joints. Provide equipment ground bus in all panelboards and isolated ground bus in all panels with isolated ground circuits. 200% neutral shall be as indicated on drawings.

2. Enclosures:
   a. Cabinets With:
      (1) Galvanized sheet steel back box.
      (2) Door-in-door hinged construction. Provide with hinged door for breaker access within hinged door for wiring compartment access. Applies to all panels up to 1200 amps bus.
      (3) Lapped and welded corners.
      (4) Enclosure cover paint shall match wall paint for all panelboards located in the hallway. Coordinate with Architect for exact color.
   b. Hardware - Chrome Plated With:
      (1) Flush Lock and Catch: Up to 48" high doors.
      (2) Vault Handle, Lock, and 3-Point Catch: Larger than 48" high doors.
      (3) All locks shall be keyed alike.
   c. Hinges:
      (1) Semi-concealed, five kuckle steel with non-ferrous pins.
      (2) 180 degree opening.
      (3) Locate maximum of 26" on centers.
   d. Minimum Gutter Spaces:
      (1) Branch Circuit Panels: 5-3/4" sides, top and bottom.
      (2) Power Panels - 400 Amp Mains: 9" sides, 12" top and bottom.
      (3) Power Panels - 600, 800, and 1200 Amp Mains: 12" sides, 12" top and bottom.
      (4) Increase sizes where required by code and through feeders.
   e. Directory:
      (1) Holder: Metal frame with clear plastic, transparent cover.
      (2) Typewritten list indicating feeder cable and conduit size, circuit numbers, outlets supplied and their locations and feeder origin.
      (3) Provide duplicate panel schedules in maintenance manual.

3. Provide each branch circuit panelboard with 20% spare 20 amp, single pole circuit breakers,
minimum. Refer to panel schedules.

E. Acceptable Manufacturers for switches, circuit breakers or panelboards shall be Square D, Cutler-Hammer, or approved equal.

2.04 Motor Controllers

A. Enclosed within motor control centers and individually mounted as indicated. Individually mounted starters in NEMA Type I enclosure, except as noted.

B. Components:

1. Terminals: Copper.

2. Overload Protection: In each phase leg with reset in enclosure.

3. Pilot Lights:
   a. Six volt incandescent lamps, of accepted color.
   b. Candelabra base receptacle with transformer for lamps.
   c. Positive indication for motors with local disconnect switches.


5. Fuses: As indicated.

6. Auxiliary Relays: To supplement auxiliary contact in controllers - Minimum 10 watt coil and two 10 amp form C contacts.

C. Manual Type:

1. Toggle switches with overload protection.


D. Magnetic Type:

1. Coil: Minimum 10 watt, 110 to 125 volt operating.

2. Contacts: Main line and minimum two 10 amp auxiliary.

3. Control Transformer: For motors over 120 volts to step down control voltage to 120 volts; of required capacity with fuse and ground connection on low voltage side. Not required if external control circuit specified on Drawings.


5. Single phase protection.

E. Controller Type: Similar to Cutler-Hammer, of catalog numbers specified, modified as noted. Coordinate controller and auxiliaries with motors supplied.

1. Manual - Single Speed:
a. Single or two pole, as required.
b. Pilot Light Red for “ON” position only.
c. HOA selector switch for automatic operation.
d. Catalog No. 9101.

2. Magnetic - Single Speed - Non-Reversing:
   a. Full voltage non-reversing magnetic starter.
   b. START-STOP pushbuttons, or HOA selector switch, as required.
   c. Reset button and pilot lights.
   d. Catalog No. A30, with combination switch.
   e. Catalog No. A10, starter only.

3. Magnetic; Two Speed - Non-Reversing:
   a. Two speed, one winding.
   b. FAST-SLOW-STOP pushbuttons, or selector switch, as required.
   c. Pilot lights; red for FAST-SLOW and green for OFF positions.
   d. Catalog No. A700.

4. Magnetic; Reduced Voltage, Non-Reversing:
   a. Reduced inrush, part winding type.
   b. Magnetic starter.
   c. START-STOP pushbutton, or HOA selector switch, as required.
   d. Reset button and pilot lights.
   e. Catalog No. A460.

5. Hand-Oft-Automatic (HOA) Station:
   a. HOA selector switch.
   b. Pilot lights.
   c. Lockout provision.
   d. Oil tight.
   e. Catalog No. 10250T.


2.05 Separately Enclosed Combination Starters
A. Shall meet the requirements of Motor Starters, above, except starter and disconnect device shall be housed together in enclosure of required type meeting or exceeding NEMA standards. Combination starter shall be of size and rating as shown on Drawings and shall utilize fused switches.

2.06 Contactors

A. Multi-Circuit Contactor: Shall be furnished in ampere rating and number of poles as shown on schedules or Drawings. Shall either be mounted inside panelboard enclosure or in NEMA 1 enclosure adjacent to panelboard as noted.

1. Multi-pole, mechanically held with dual acting single solenoid mechanism.
2. Operable in any mounting position.
4. Double-break continuous duty 20'amp contacts at 600 volts AC.
5. 2 to 12 pole capacity on single coil.
6. 120 volt, 3wire control coil.
7. Similar to ASCO 917 with accessory 48A, Square D Class 8903. Series with auxiliary relay for two wire control, or approved equal.

2.07 Lighting Control Relay Panel

A. Low Voltage Relay Panel

1. Components
   a. Tub, similar to GE #RTUB24
   b. Interior with 24 relays, similar to GE #RINTER0024RC
   c. Relays similar to GE #RR7P
   d. Power Supply, similar to GE #RPWR115
   e. Cover, similar to GE #RCOV24SL

2. Make all necessary connection's to building EMS.
3. Refer to Lighting Control Relay Schedule for circuits controlled.

2.08 Devices

A. Local Wall Switches:

1. Heavy duty, rocker, quiet type.
2. 20 amp, 120/277 volt, AC.
3. Similar to Hubbell Catalog Nos. as Follows:
   a. Single pole, No. 1221-WHI.
b. Double pole, No. 1222-WHI.
c. Three-way, No. 1223-WHI.
d. Illuminated handle:
   (1) Single pole, No. 1221-ILC
   (2) Three-way, No. 1223-ILC

4. Color shall be gray or concrete surfaces or surfaces painted with accent colors otherwise color shall be white.

B. Dimmer Switches

1. Linear slide to off.
2. Heavy duty components.
3. 277 Volt
4. Similar to Leviton #NTF-10-277
5. Color shall be gray or concrete surfaces or surfaces painted with accent colors otherwise color shall be white.

C. Occupancy Sensors

1. General
   a. Provide a complete occupancy sensor lighting control system consisting of all necessary occupancy sensors, wall switches, switchpacks, junction boxes, wiring, etc., as required by the manufacturer for a complete, operational system. Manufacturer shall obtain drawings and layout devices required based on their product coverage as shown on the drawings.
   b. Branch circuits for light fixtures controlled via the motion sensor system shall be routed through the appropriate sensor or switchpack as indicated on the wiring diagrams shown on the plans and as provided by the manufacturer.
   c. All low voltage control wiring shall be run in EMT conduit.
   d. Provide all required low voltage cabling.
   e. All occupancy sensor system components shall be certified to the California Energy Commission, comply with CCR, Title 24, Part 2, and be UL-listed.
   f. All occupancy sensor system components shall be compatible for use with electronic lamp ballasts.

2. Components:
   a. General:
      (1) The components of the motions occupancy sensors system shall be commercial “specification” grade and shall be supplied by a single manufacturer.
(2) Contractor shall thoroughly review the operational and performance requirements of the system with the manufacturer to verify the wiring and equipment requirements prior to bid. Contractor shall verify proper mounting locations and coverage requirements with manufacturer prior to commencing any work.

b. Basic Equipment:
   (1) Similar to Watt Stopper P&S Catalog number, or equal.
   (2) Ceiling Sensors
      a) Large Conference Rooms, DT300, coverage as required. -2000
      b) Restrooms: WT series, coverage as required.
      c) Corridors: WT-2255
      d) Open Office: WT2205


d. Wall Switch: WA300 (dual level) WA200 (non-dual level)

e. Color shall be gray or concrete surfaces or surfaces painted with accent colors otherwise color shall be white.

D. Insertion Receptacles:
   1. Grounded, except as noted.
   2. Similar to Hubbell Catalog Nos. as Follows: (P&S, Cooper or equal)
      a. Duplex Convenience, Specification Grade:
         (1) 125 volts, 2 pole, 3wire, Uground slot.
         (2) All nylon, smooth face.
         (3) 20 amp, similar to No. 5362 WHI.
         (4) Color shall be gray or concrete surfaces or surfaces painted with accent colors otherwise color shall be white.
      b. Single, Specification Grade:
         (1) 125 volt, 2 pole, 3wire, grounded.
         (2) All nylon, smooth face.
         (3) 20 amp, similar to No. 5361
      c. Ground Fault, Specification Grade:
         (1) 125 volt, 2 pole, 3 wire, with indicator light.
         (2) 15 amp, 20 amp feed-thru.
d. Outdoors:
   (1) Duplex convenience.
   (2) Weatherproof, lift-lid aluminum hinged covers. Similar to Leviton 4970.

e. Special Receptacles: As noted.

E. Device Plates:

1. 0.100· smooth finish stainless steel on concrete surfaces and surfaces painted with accent colors. Otherwise color shall be white.

2. Lexan with retaining screws painted to match plate. P&S or equal.

3. For receptacles with other than 120 volt, inscribe voltage available.

4. Engrave Gang type where two or more are installed at one location.

F. Acceptable Manufacturers - Similar To:

1. Local Wall Switches, Receptacles and Device Plates:
   a. P&S.
   b. Cooper.
   c. Harvey Hubbell, Inc.

2.09 Inserts and Supports

A. Concrete Fasteners: Phillips "Red-Head" or approved equal. Power driven concrete pin fasteners, low velocity type. Powder driven fasteners shall be Remington, Ramset or approved equal powder-driven concrete pin fasteners, low velocity type.

B. Conduit Straps: Hot-dip galvanized, cast malleable iron, One hole type strap with cast clamp-backs and spacers as required. O2/Gedney No. 14-50G strap and No. 141G spacer; Efcor No. 231 strap, and No. 131 spacer; or approved equal.

C. Concrete Inserts: Pressed galvanized steel, spot insert, with oval slot capable of accepting support nuts of 1/4" to 1/2" diameter thread. Unistrut No. M2506 series; Globe-strut CSI series, or approved equal.

D. Construction Channel: 1-1/2" x 1-1/2" 12 gauge galvanized steel channel with 17/32" diameter bolt holes, 11/2" on center, in the base of the channel. Kindorf 905 series, Unistrut P-1000-HS, or approved equal.

E. Cable Ties and Clamps: Thomas and Betts Co. "Ty-Raps", Panduit "Pan-ty" or approved equal, one piece, nylon, reusable type lashing ties.

F. Fasteners (General): Wood screws for fastening to wood. Machine screws for fastening to steel. Toggle bolts for fastening to gypsum board, or plaster walls. Expansion anchors for attachments to pre-poured concrete.

G. Grouped Lines and Services: Supported by trapeze hangers of bolted angle or channels.

H. Where building construction is inadequate, provide additional acceptable framing after review.
I. 3/8" threaded rod for all raceway supports.

2.10 Telecommunications Systems

A. Empty conduit telecommunication raceway system cabling and outlets as indicated on the Drawings, and consisting of:
   1. Empty conduit/cable tray. All conduit will be type "CO or greater.
   2. Pull boxes, as indicated or after two 90 degree bends.
   3. Terminal strip cabinets.
   4. Terminal boards.
   5. Sleeves, including fireproofing.
   6. Fishwires.
   7. Systems shall conform to requirements of the California State University Monterey Bay.
   8. Multi-cell conduit will be used for fiber optic cable installation.

B. Components:
   1. Terminals Boards: Fireproof plywood, size as indicated.
   2. Wall Outlets: 4-11/16" square, 2 1/8" deep with device plate, unless otherwise noted on plans.
   3. Conduit as described in Raceway Article of this Section.
   4. Telecommunication conduit and wiring shall be kept at least 12” away from light fixtures containing ballasts.
   5. Conduit:
      a. All conduits designed for hard line cable installation shall utilize sweep bends with a minimum radius of 24", and where underground, shall have a 36" min. radius if trench depth and point of attachment permit. The use of condulets or other such devices is expressly prohibited.
      b. Conduits for hardline cable shall be a minimum of 2" for 1 or 2 .500" cables and a minimum of 2-1/2" for larger cables. Conduit sizes for multiple cables will be supplied upon request.
   6. Terminal Cabinets & Enclosures: Any terminal cabinet or pull box designated for the installation of hard line coaxial cable shall be a minimum of 24” square, with a minimum depth of 6”. Size shall be increased appropriately when multiple cables will be housed or spliced in the enclosure. Cabinets or pull boxes for flexible or drop cables shall be a minimum of 12” square, with a minimum depth of 4”. Boxes containing more than 12 cables shall be increased in size incrementally.

PART 3 – EXECUTION

3.01 General

A. Drawings are diagrammatic and indicate general arrangement of systems and work included. Follow Drawings in laying out work and check Drawings of other trades relating to work to verify spaces in which work will be installed. Maintain headroom and space condition to all points.
B. Set and layout work on premises. Base all measurements from approved bench marks and correct setting or work to agree with established lines and levels. Should discrepancy exist between actual measurements and those indicated, notify Architect in writing and do not proceed with work affected until written instructions are received from Architect.

C. All minor appurtenances not specifically mentioned herein that are necessary to make a complete working installation, are included in the work with any necessary field engineering or detail drawings required. Submit Drawings as specified in Article 1.04 of this Section.

D. Install equipment rigid and secure, plumb and level, and in true alignment with related and adjoining work. No welding of electrical materials for attachment or support is permitted.

E. Provide templates, layout drawings, and supervision to ensure correct placing of anchorage items in concrete, and check embedded items for correctness of location and detail before concrete is placed.

F. Provide supporting members as required to set and connect all raceways and equipment to the structure rigidly.

G. Correct noise and vibration exceeding specified limits or due to faulty equipment at no expense to Owner.

H. Changes of magnitude involving extra cost not allowed without written approval by the Architect.

I. Group concealed equipment requiring access with equipment freely accessible through access doors.

J. Cutting: Cutting shall conform with requirements specified in the Division-1 Section dealing with cutting.

K. Patching: Patching shall conform with requirements specified in the Division-1 Section dealing with patching.

3.02 Heights of Outlets

A. Heights of outlets from finished floor to centerline of outlets shall be as indicated on the electrical plans and Architectural plans and elevations. Where not indicated in either place, use the following:

1. Receptacles: +18”

2. Wall Switches: +42”.

3. Motor Controllers and Pushbutton Stations: 5’.

4. Fire Alarm Audible Devices: 7'-6”.

5. Exceptions:
   a. At junction of different wall finish materials.
   b. Above or within fixed counters or equipment.
   c. On molding or break in wall surface.
   d. To accommodate specific fixed equipment.
   e. Where the above heights do not meet the requirements of the applicable codes.
   f. Where indicated differently on plans.

3.03 Installation of Raceways
A. Raceways shall be run concealed, except as noted.

B. Raceways are allowed in all above-grade slabs on metal deck where the overall diameter is less than 1/3 of the slab thickness and approved in writing by the Structural Engineer.

C. Supports Shall be as Follows:
   1. Ceiling trapeze, hanger rods, or wall brackets.
   2. U-bolt or pipe straps at each floor level of riser raceways.
   3. Raceways shall be secured to support with pipe straps or U-bolts.
   4. Spacing shall be a maximum 5’ on centers for metallic conduit and wireways. Supports within 3 ft. of each outlet box, junction box, cabinet, or fitting.
   5. Supports shall be mounted to structure with:
      a. Toggle bolts on hollow masonry.
      b. Expansion shields or insets on concrete.
      c. Machine screws on metal.
      d. Wood screws on wood.
      e. Nails, rawl plugs or wood plugs shall not be permitted.

D. All raceways shall be run parallel with, or at right angles to, walls.

E. Clearance From Water, Steam or Other Piping: Minimum 3” separation from hot water pipes, except 4” from pipe cover at crossings.

F. Keep raceways clear of motor foundations and underside of boilers.

G. Raceways for outlets in hung ceiling shall be run in hung ceilings.

H. Run raceways in walls vertically.

I. Maintain grounding continuity of interrupted metallic raceways with ground conductor.

J. Empty Raceways Over 10’ Long: Provide with pull wire.

K. Steel Conduit:
   1. Paint threads of field threaded conduit with graphite base pipe compound.
   2. In slabs, maximum outside diameter not to exceed 1/3 of the slab thickness.
   3. Direct Buried Conduit: Provide continuously with waterproofing tape, half lapped, or two coats of asphaltum paint, dried thoroughly between paintings and before backfilling.
   4. Minimum 1” cover in concrete fill.

L. EMT: Install generally for interior, except buried in concrete slabs on grade.
M. Flexible Steel Conduit:

1. For short connections where rigid conduit is impracticable.
2. From Outlet Box to Recessed Lighting Fixture: Minimum 4', maximum 6' length.
3. For Final Connection to Motor Terminal Box and Transformers With Polyvinyl Sheathing: Minimum length 18" with minimum 50% slack.

N. MC Cabling:

1. MC cable is acceptable for concealed power branch circuit wiring in the following areas: Walls and ceilings in offices, classrooms and administrative areas; Utility rooms, corridors and lobbies, toilet and storage rooms where there is no access floor. MC cable is also acceptable for concealed lighting branch circuiting.
2. Install [MC] cable in accordance with manufacturer's instructions and in accordance with NEC Article [334]. Follow manufacturer's instructions when connecting the cable to fittings and boxes. Security connectors to the cable, but not overtightened. Firmly attach connector to the metal boxes.
4. Do not support cables from raceways or mechanical piping.
5. Do not rest cables on ceiling tiles or allow contact with mechanical piping systems.
6. Provide 1/4 inch threaded or solid rod grid, 4 feet on centers, above ceiling spaces for cable support. Use spring metal clip for cable attachment to rod.
7. Cable connection to light fixtures: Acceptable to attach cable to fixture support wire using spring metal clip.
8. Use steel with insulated throat cable connectors. OZ/Gedney AMC Series or equivalent. Die cast or pressure cast fittings are not permitted.
9. Use cable having color code conductors as noted. Color coded conductor sleeves are not permitted.
10. Provide separate sleeves and/or fire barriers for cable fire wall penetration, unless cable is UL listed for the application.
11. MC cable is not permitted for homerun use except for interface with manufactured wiring system at distribution box under raised floor. Extend cable from junction/way box having branch circuits for the immediate area. For lighting system, use conduit for routing branch circuit conductors from junction/way box to the panelboard.

O. Conduit Terminations and Joints:

1. Raceways shall be joined using specified couplings or transitions couplings where dissimilar raceway systems are joined.
2. Conduits shall be securely fastened to cabinets, boxes and gutters using two locknuts and an insulating bushing or specified insulated connectors. Install grounding bushings or bonding jumpers on all conduits terminating at concentric knockouts.
3. Conduit terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using specified connectors and hubs.
4. Install expansion couplings where any conduit crosses a building separation or expansion joint.

5. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating in switchgear, cabinets or gutters inside the building. Install cable sealing bushings or caulk conduit terminations in all grade level or below grade exterior pull, junction or outlet boxes.

P. Conduit Penetrations:

1. Furnish and install metal sleeves for all exposed interior conduit runs passing through concrete floors or walls. Following conduit installation, seal all penetrations using non-iron bearing, chloride free, non-shrinking, dry-pack, grouting compound.

2. Install specified watertight conduit entrance seals at all below grade wall and floor penetrations. Conduits penetrating exterior building walls and building floor slab shall be insulated rigid steel.

3. For roof penetrations furnish and install roof flashings as specified under built-up bituminous roofing and sheet metal Sections of the Specifications.

4. At fire separation walls or floors, penetrations shall be sealed with material capable of preventing the passage of flames and hot gases, when subjected to the requirements of the test standard specific of Fire Stops ASTM-E-814. Provide a UL through penetration fire stop system number for each condition as per 1990 UL Fire Resistance Directory.

Q. Outlet Boxes:

1. Set square and true with building finish and secure to building structure by adjustable strap irons.

2. Verify outlet locations in finished spaces with Drawings of interior details and finishes.

3. Provide barriers between switches connected to different phase for voltages exceeding 150 volts to ground.

R. Panel, Junction and Pull Boxes:

1. Location: Clear of other work. Conceal junction and pull boxes in finished spaces and maintain accessibility.

2. Support from building structure, independent of conduit.

3. Outlet Boxes for Fixtures Recessed in Hung Ceiling: Accessible through opening created by removal of fixture.


5. Whether shown or not, pull boxes are required after three 90 degree bends in any conduit run.

6. Pullboxes and junction boxes for all systems should be identified by a color coding system in order that they can be easily located and identified in the future. Where boxes are located in concealed spaces, the color coding system should be as follows:

   a. 480 volt normal power system: YELLOW

   b. 208 volt normal power system: BLUE

   c. Fire alarm system: RED

   d. Data Processing/Telecommunications system: PURPLE
3.04 Conduit and Raceway Applications

A. Rigid Steel Conduit:
   1. Feeders and branch circuits, indoors, exposed and suspended ceilings, in crawl spaces, attics, chases, furred spaces, and in equipment rooms.
   2. Feeders and branch circuits concealed in concrete floors and walls not in contact with earth.
   3. Where required by Utility or local inspection department.

B. Intermediate Metal Conduit (IMC): May be used for the same application as rigid steel conduit as specified under this Section.

C. Electrical Metallic Tubing (EMT): Feeders 4" and smaller, interior power and lighting branch circuits, and low tension (telephone and signal) distribution system where run concealed above suspended ceilings in concrete slabs not in contact with earth, in stud walls, furred spaces and where exposed not less than 6’ above finished floors.

D. Flexible Metallic Conduit In dry locations for connections from adjacent outlet boxes to motors, transformers, vibrating equipment and machinery and to lighting fixtures installed in suspended ceilings.

E. Liquidtight Flexible Metallic Conduit: In damp or wet locations for the same applications as for flexible metallic conduit specified under this section. Connections to all pump motors, solenoid valves, motor or hydraulically operated valves, float switches, flow switches, and similar devices shall be made using liquidtight flexible metallic conduit.

3.05 Installation of Wire and Cable

A. 600 Volt Cable:
   1. Pull no thermoplastic wires at temperatures lower than 32 degrees F.
   2. Separate raceways for conductors of 120/208 and 277/480 volt systems, except 480 volt motor branch circuit wiring and related 120 volt control wiring.
   3. Install a code sized ground conductor in all conduits. Increase conduit size where required to accommodate this wire.

3.06 Installation of Low Voltage Distribution Equipment

A. Distribution Panels Shall be Installed as Follows:
   1. Circuit wiring shall be distributed evenly over three phases. Circuit numbers are for identification purposes only.
   2. Provide multi-cable lugs where required. Double lugging shall not be permitted.
   3. Mounting height shall be maximum 6’-6” from floor to top switch unit.
   4. When located flush in walls or in rooms without direct access to an area with accessible ceilings, furnish and install on 3/4”empty conduit for each 2 single pole spares or spaces to an accessible ceiling location.
   5. Train, bundles and tag with circuit identification markers all branch circuit wiring in panelboard gutters.
Installation of Motor Controllers

A. Determine exact controller locations of individually mounted controllers.

B. Mount individual controllers on walls, columns or angle steel frame work as indicated on Drawings, or as required.

C. Furnish & install control wiring to control devices to start and stop motors.

Installation of Power, Control and Alarm Wiring System

A. General: Complete wiring from service to distribution and utilization equipment and as described below.

B. Motor Wiring:

1. Under Electrical Work, Unless Otherwise Noted:
   a. Disconnect switches.
   b. Motor controllers.
   c. Wiring from power source to motors, disconnect switches and control devices, and motor controllers.
   d. Interconnection wiring between mechanical control devices, Life Safety equipment, and starters.

2. Motor Terminal Boxes: Provide motor suppliers with minimum requirements to receive indicated wiring.

3. Raceways:
   a. Rigid conduit or electric metallic tubing except flexible (with slack) for final motor connection.
   b. Install clear of motor foundations.
   c. Allow clearance for motor removal and maintenance.

C. Elevator Wiring:

1. Under Electrical Work:
   a. Elevator machine room lighting, convenience receptacles, pit lights with guards, and convenience receptacles.
   b. Disconnect switches and/or power panels.
   c. Wiring From:
      (1) Power source to elevator machine room disconnects to control panels or motor starters and control relay panels.
      (2) Fire alarm system or smoke detectors to elevator controller for recall.
      (3) Local 120 Volt Sources To: Elevator starter panel and remote alarm panel, elevator cab lights. Furnish and install a dedicated circuit through a local toggle switch for each controller whether shown or not.
d. Raceway from local telephone terminal board to each elevator controller.
e. Interlock between FACP and each elevator controllers for Life Safety system connections.

2. Under Elevator Work:
   a. Motors, generators and starters.
   b. Control panels.
   c. Control relay panels.
   d. Starters panels.
   e. Remote alarm panels.
   f. Wiring of starters panels.
   g. Wiring Beyond:
      (1) Control panels or motor starters.
      (2) Control relay panels.

D. Motor-Operated Door Wiring:
   1. Under Electrical Work:
      a. Mount controllers and control devices.
      b. Wiring from power source to motors, controllers, and control devices.
   2. Under General Construction Work: Motors, controllers, and control devices.

E. HVAC Temperature Control and Motor Interlock Wiring:
   1. Under Electrical Work: Motor interlock wiring in accordance with sequence of operation and/or wiring diagrams provided under Divisions 15 and 16.
   2. Under HVAC Work: Furnishing of all temperature control Wiring.

F. Wiring Diagrams:
   1. Obtain required wiring diagrams for respective work of other trades and provide wiring as indicated by these diagrams and in accordance with applicable Specifications.

G. Fire Sprinkler System:
   1. Under Electrical Work:
      a. Wiring of all flow, tamper and position indicating devices to FACP.
   2. Under Sprinkler Work:
      a. Furnishing and installing all equipment and devices.
H. Signal and Communication Systems:
   1. All cabling for data, telephone, cable TV, paging, and other unspecified signal or communication systems shall be plenum rated cable.
   2. All the plenum cable systems shall be routed via a J-hook support system and each different cable system shall be separately bundled with ty-raps and labeled with tags on intervals not to exceed 5 feet.

3.09 Field Tests
   A. General: Perform field tests in the presence of the Architect except as otherwise specified. Provide required labor, materials, equipment and connections to perform tests, document results and submit them to Architect for approval and repair or replace all defective work.
   B. Tests on 600 Volt Wire and Cable:
      1. Perform the Following Test Prior to Connecting the Equipment:
         a. Megger test on all feeders, 20% of branch circuits and all motor branch circuits 10 HP and over.
   C. Tests on Low Voltage Distribution Equipment:
      1. Open and close switching devices under load.
   D. Tests on Motor Starters: Verify operation of starters and install overload protection devices sized in accordance with the motor full load current.

3.10 Cleaning
   A. Brush and clean work prior to concealing, painting and acceptance. Performed in stages if directed.
   B. Clean and repair soiled or damaged painted exposed work and match adjoining work before final acceptance.
   C. Remove debris from inside and outside of material, equipment and structures.

END OF SECTION
SECTION 16060

SUPPORTS AND ANCHORS

PART 1 – GENERAL

1.01 Work Included

A. Multioutlet supports.
B. Raceway supports.
C. Conduit supports.

PART 2 – PRODUCTS

2.01 Acceptable Manufacturers

A. Supports:
   1. OZIGedney
   2. Appleton
   3. Thomas and Betts
   4. Minerallac
   5. Midwest Electric
   6. Unistrut
   7. B-Line
   8. Kindorf
   9. Super Strut
   10. Erica Products (Caddy)

B. Anchors
   1. Hilti
   2. Red Head
   3. Raw Plug
   4. Star Expansion

C. Fasteners and supports as manufactured by Caddy are not acceptable unless otherwise noted.

2.02 Metal Surface Raceways and Multioutlet Assemblies

A. Fasteners and Supports:
1. Wood: Flat-head wood screw.
2. Dry Wall: Plastic anchor with flat-head wood screw.
4. Brick, Masonry or Block: Masonry nail.
5. Tile: Toggle bolt.
6. Concrete: Drive pin fastener.

2.03 Conduit

A. Single Conduit:

1. Supported from beam flange:
   a. Beam Clamp:
      (1) Appleton No. BH500 for conduit 1 inch and smaller
      (2) Appleton No. BH502 for conduit 1-1/4 inches and larger
   b. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac No. O-B through 10-B as required.
   c. Support: Machine screw between clamp and hanger.

2. Supported and suspended from beam flange:
   a. Beam Clamp:
      (1) Appleton No. BH500 for conduit 1 inch and smaller.
      (2) Appleton No. BH502 for conduit 1-1/4 inches and larger.
   b. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac No. O-B through 10-B as required.
   c. Rod: Zinc-plated or galvanized steel, threaded, Minerallac.
      (1) 1/4 inch diameter for conduit 1 inch and smaller.
      (2) 3/8 inch diameter for conduit 1-1/4 inches and larger.
   d. Support:
      (1) Nut on rod on both the inside and outside of the clamp; outside nut to act as locking nut.
      (2) Nut on rod on inside of hanger.

3. Supported from concrete slab or roof:
   a. Support: One-hole strap, Minerallac MIN-E snap-on clip.
   b. Concrete Insert: Phillips Redhead, ‘J’ or ‘S’ Series.
4. Supported and suspended from concrete slab or roof:
   a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac No. O-B through 10-B as required.
   b. Rod: Zinc-plated or galvanized steel, threaded, Minerallac.
      (1) 1/4 inch diameter for conduit 1 inch and smaller.
      (2) 3/8 inch diameter for conduit 1-1/4 inches and larger.
   c. Support: Nut on rod on inside and outside of hanger.
   d. Concrete Insert: Phillips Redhead, ‘J’ or ‘S’ Series.

5. Supported from metal deck:
   a. Support: One-hole strap, Minerallac MIN-E snap-on clip.
   b. Anchor in Deck: No. 10 x 3/4 inch pan-head sheet metal screw.

6. Supported and suspended from metal deck:
   a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac No. O-B through 10-B as required.
   b. Rod: Zinc-plated or galvanized steel, threaded, Minerallac.
      (1) 1/4 inch diameter for conduit 1 inch and smaller.
      (2) 3/8 inch diameter for conduit 1-1/4 inches and larger.
   c. Support: Nut on rod on inside and outside of hanger.
   d. Anchor in Deck: Fender washer with nut.

7. Supported from concrete, or hollow masonry wall:
   b. Anchor:
      (1) Concrete: Phillips Redhead, ‘J’ or ‘S’ Series.
      (2) Masonry Wall: Molly bolt.

8. Supported from damp or outside concrete wall:
   a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac No. O-B through 10-B as required.

B. Multiple Conduits:
1. Supported from concrete slab or roof:
   a. Support: One-hole strap, Minerallac MIN-E snap-on clip.
2. Supported and suspended from concrete slab or roof:
   a. Conduit Hanger: Unistrut pipe clamp No. P11 00 Series for rigid and No. P1200 Series or EMT.
   c. Support:
      (1) Unistrut No. P-1000, length as required.
      (2) Nut on rod on outside of unistrut and unistrut spring-loaded nut on inside of unistrut.
   d. Concrete Insert: Phillips Redhead, ‘J’ or ‘S’ Series.

3. Supported from metal deck:
   a. Conduit Hanger: Zinc-plated steel with bolt and nut, Minerallac No. O-B through 10-B as required.
   b. Anchor in Deck: Fender washer with nut.

4. Supported and suspended from metal deck:
   a. Conduit Hanger: Unistrut pipe clamp No. P11 00 Series for rigid and No. P1200 Series or EMT.
   c. Support:
      (1) Unistrut No. P-1000, length as required.
      (2) Nut on rod on outside of unistrut and unistrut spring-loaded nut on inside of unistrut.
   d. Anchor in Deck: Fender washer with nut.

5. Supported from concrete or hollow masonry wall:
   a. Conduit Hanger: Unistrut pipe clamp No. P11 00 Series for rigid and P1200 Series for EMT.
   b. Support: Unistrut No. P-1000, length as required.
   c. Anchor:
      (1) Concrete Insert: Phillips Redhead, ‘J’ or ‘S’ Series.
      (2) Masonry Wall: Molly bolt.
2.04 Sleeves

A. EMT steel conduit for conduit penetrations through rated walls and floors.

B. Conduit sleeve to be minimum of 1 inch larger in diameter than penetrating conduit.

PART 3 – EXECUTION

3.01 Conduit Supports

A. Support Horizontal Conduit as Follows:

<table>
<thead>
<tr>
<th>Nominal Maximum Distance Conduit Between Supports (feet)</th>
<th>Rigid</th>
<th>EMT</th>
<th>Flexible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (inches)</td>
<td>Nominal Maximum Distance Conduit Between Supports (feet)</td>
<td>Rigid</td>
<td>EMT</td>
</tr>
<tr>
<td>½</td>
<td>6</td>
<td>5</td>
<td>4-1/2</td>
</tr>
<tr>
<td>¾</td>
<td>6</td>
<td>5</td>
<td>4-1/2</td>
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<tr>
<td>1</td>
<td>6</td>
<td>5</td>
<td>4-1/2</td>
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<tr>
<td>1-1/4</td>
<td>7</td>
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<td>4-1/2</td>
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<td>4-1/2</td>
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<tr>
<td>3</td>
<td>8</td>
<td>8</td>
<td>4-1/2</td>
</tr>
<tr>
<td>3-1/4</td>
<td>10</td>
<td>10</td>
<td>4-1/2</td>
</tr>
<tr>
<td>B. Rigid galvanized steel and EMT shall be supported within 3 feet of every outlet box, junction box, cabinet, or fitting. Flexible conduit 1 feet.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Support vertical conduit at every floor with a maximum of 10 feet between supports.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.02 Sleeves

A. Provide conduit sleeves for every fire-rated wall or floor where conduit penetrates.

3.03 Anchors

A. Anchors shall be installed using the proper drill bits and power tools.

B. Anchors shall be installed per the manufacturer’s recommendations.

3.04 Commissioning

A. Refer to Sections 16950, TESTING REQUIREMENTS, and 16010, ELECTRICAL GENERAL PROVISIONS, for system performance verification requirements.

END OF SECTION
SECTION 16112
MULTI-OUTLET ASSEMBLIES

PART 1 – GENERAL

1.01 Related Documents
   A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.02 Work Included
   A. Multi-outlet assemblies.

1.03 Submittals
   A. Submit product data on multi-outlet assemblies.

PART 2 – PRODUCTS

2.01 Acceptable Manufacturers
   A. Wiremold
   B. Thomas & Betts / Steel City
   C. Or approved equal.

2.02 Types
   A. Multi-outlet Assembly:
      1. Two-piece, steel, white color with divider and all fittings as required:
         a. #4000 with outlets at centers as indicated on plans.
         b. #4046B, combination duplex receptacle & telephone outlet cover for typical outlets. See electrical plans and architectural plans for locations.
      2. Receptacles: 3-wire, grounding type, 20 amp, 125 volt, Specification Grade, white color.
      3. Contractor shall be responsible for coordination of multi-outlet assemblies installation in casework, cabinets, etc., with casework supplier.
      4. Multi-outlet assembly shall meet all requirements of the CEC Article 353 and shall be UL listed in full compliance with UL standard for surface metal raceways and fittings (UL-5).

PART 3 – EXECUTION

3.01 Installation
   A. Multi-outlet Assembly:
      1. The raceway shall be mounted rigidly on the wall and continuously level. See Section 16060 for types of supports and anchors.
2. The number of outlets, spacing, and mounting height shall be as shown on the Drawings.

3. Provide separate green grounding wire.

4. Where more than 1 circuit feeding the raceway is indicated, the receptacles are to be wired alternately, unless otherwise noted.

5. Provide dividers in raceway wherever normal power, or low voltage systems occur in the same raceway.

END OF SECTION
SECTION 16114
CABLE TRAY

PART 1 – GENERAL

1.01 Section Includes

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete wire basket support systems as shown on the drawings.

B. Wire basket support systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.

1.02 References


B. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel

C. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process


F. NEMA VE 2-2000 - Cable Tray Installation Guidelines.

1.03 Drawings

A. The drawings, which constitute a part of these specifications, indicate the general route of the wire basket support systems. Data presented on these drawings is as accurate as preliminary planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.04 Submittals

A. Submittal Drawings: Submit drawings of wire basket and accessories including connector assemblies, clamp assemblies, brackets, splice plates, splice bars, grounding clamps and hold down plates showing accurately scaled components.

B. Product Data: Submit manufacturer's data on wire basket support system including, but not limited to, types, materials, finishes and inside depths.

1.05 Quality Assurance

A. NEC Compliance: Comply with NEC, as applicable to construction and installation of cable tray and cable channel systems (Article 318, NEG).

B. NFPA Compliance Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.
1.06 Delivery, Storage and Handling

A. Deliver wire basket support systems and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged equipment.

B. Store wire basket and accessories in original cartons and in clean dry space; protect from weather and construction traffic.

PART 2 – PRODUCTS

2.01 Acceptable Manufacturers

A. Manufacturer: Subject to compliance with these specifications, wire basket support systems to be installed shall be as manufactured by:

1. Cooper B-Line, Inc.

2. GS Metals, Flextray

3. Snake Tray

4. Wiremold – Fieldmate

5. Engineered approved equal

2.02 Wire Basket sections and Components

A. General: Provide wire basket of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

1. Nominal size shall be 2 X 24

2. Other widths and components to provide a continuous fill capacity equal to the nominal size.

B. Materials and Finishes: Material and finish specifications for each wire basket type are as follows:

1. Zinc Dichromate: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc dichromate in accordance with ASTM B633 SC2.

2. Pre-Galvanized Zinc: Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.

3. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.

2.03 Type of Wire Basket Support System

A. All straight section longitudinal wires shall be straight (with no bends).

B. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

C. Wire basket sizes shall conform to the following nominal criteria:
1. Straight sections shall be furnished in standard 118 inch lengths.
2. Wire basket shall have a 2 inch usable loading depth by [2][4][6][8][12][18][24] inches wide.

D. All fittings shall be field formed as needed.
E. All splicing assemblies shall be the bolted type using serrated flange locknuts. Hardware shall be either zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 Stainless Steel or equal.
F. Wire basket supports shall be compatible with the access floor supports and as manufactured by the wire basket manufacturer.
G. Trapeze hangers or center support hangers shall be supported by 1/4 inch or 3/8 inch diameter rods.
H. Special accessories shall be furnished as required to protect, support and install a wire basket support system.

PART 3 – EXECUTION

3.01 Installation

A. Install wire basket as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
B. Coordinate wire basket with mechanical and other electrical work as necessary to properly interface installation of wire basket runway with other work.
C. Provide sufficient space encompassing wire basket to permit access for installing and maintaining cables.

3.02 Testing

A. Test wire basket support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. see NFPA 70B, Chapter 18, for testing and test methods.
B. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.

END OF SECTION
SECTION 16116
RAISED FLOOR BOXES

PART 1 – GENERAL

1.01 Summary
A. Raised floor boxes.

1.02 References
A. NECA - Standard of Installation.
B. NEMA FB 1- Fittings and Supports for Conduit and Cable Assemblies.
C. NEMA OS 1- Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. NFPA 70 - National Electrical Code (NEG).

1.03 Submittals
A. Comply with provisions of Section 01300 - SUBMITTALS.
B. Submit manufacturer’s standard product literature identifying the exact configuration, options, and accessories to be provided.

1.04 Quality Assurance
A. All materials, equipment and parts comprising the units specified herein shall be new and unused, of current manufacturer and of highest grade.
B. Raised floor boxes shall meet Underwriters Laboratories Inc. standard UL514A and shall bear the Listing Mark.

PART 2 – PRODUCTS

2.01 Manufacturers
A. Walker Systems, Inc. – a Wiremold Company.
B. Thomas &Bels
C. Leviton
D. American Cable Systems
E. Or approved equal.

2.02 Raised Floor Box
A. The product specified herein is a Walker Systems, Inc. AF1/AF2 series raised floor box.
B. Dimensions:
1. Panel opening: 8” x 6”.
2. Module depth: 5”.
3. Device wiring chamber volume: 130 cubic inches.
4. Box volume: 208 cubic inches

C. Construction:
1. The box lid shall be constructed of polycarbonate material. The lid shall provide a removable cable guard for egress of power and communication workstation cables. The cable guards shall hold workstation cables in place with the lid either in the open or closed position.
2. The trim flange shall be constructed of polycarbonate material and have a minimum overall dimension of 8-3/4” x 6-3/4”. The hinged lid and trim flange shall be available for either carpet or tile floor applications.
3. The wiring chamber shall provide a minimum of three separate compartments to accommodate a combination of both power and communication wiring. The compartments shall be separated by use of integral, die cast aluminum built-in dividers.
4. If a prewired flexible wiring system is provided, the same manufacturer shall supply the box and the flexible wiring system. The box shall contain integral connectors to mate with the flexible wiring system. The box shall be capable of disconnecting from the flexible wiring system directly at the box. The prewired box shall be able to contain up to 3 separate circuits, utilizing up to an 8-conductor MC cable assembly.

D. Devices:
1. Two 120V duplex receptacles, NEMA 5-20R configuration, black.
2. One set: dual ST multi-mode fiber optic connectors mounted with brackets as provided by box manufacturer.
3. Four CAT 5 RJ-45 connectors, wired per TIA/EIA-568A or B, to be specified by the Owner. Provide in sets of two dual connectors mounted with brackets as provided by box manufacturer.
4. Blank inserts as required to fill out the box.

E. Color:
1. The polycarbonate box lid and trim flange shall be provided in a custom color to be determined by the Architect. A minimum of three different custom colors shall be provided.

PART 3 – EXECUTION

3.01 Examination
A. Verify locations of floor boxes and outlets prior to rough-in.

3.02 Installation
A. Install boxes in accordance with NECA - Standard of Installation.”
B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
C. Set wall mounted boxes at elevations to accommodate mounting heights indicated or specified in section for outlet device.

D. Install junction or pullboxes where required to limit bends in conduit runs to not more than 360 degrees or where pulling tension achieved would exceed the maximum allowable for the cable to be installed. Note that these boxes are not shown on the Drawings.

E. Leave no unused openings in any box. Install close-up plugs as required to seal openings.

F. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.

G. Provide precast concrete boxes in exterior planting areas, walkways, roads, etc.

H. Install raised device covers (plaster rings) on all switch and receptacle outlet boxes installed in masonry or stud walls or in furred, suspended or exposed concrete ceilings. Provide covers of sufficient depth to suit the wall or ceiling finish.

I. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.

J. Use conduit outlet bodies to facilitate pulling of conductors or to make changes in conduit direction only. Do not make splices in conduit outlet bodies.

K. Add additional sheet rock as necessary to maintain original fire rating of walls where boxes are installed.

L. Maintain headroom and present neat mechanical appearance.

M. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

N. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07270 - FIRESTOPPING AND SMOKESEALS.

O. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

P. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

Q. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

R. Use gang box with plaster ring for single device outlets.

S. Use cast outlet box in exterior locations exposed to the weather and wet locations.

T. Set floor boxes level.

U. Box color coding and marking. Refer to Section 16195 - ELECTRICAL IDENTIFICATION, for instructions.

3.03 Box Layout

A. Install all outlet boxes flush with building walls, ceilings and floors except where boxes are installed in mechanical and electrical rooms, in cabinetry, above accessible ceilings or where exposed work is called for on the Drawings.

B. Locate pullboxes and junction boxes in concealed locations above removable ceilings or exposed in electrical rooms, utility rooms or storage areas.
C. Install outlet boxes at the locations and elevations shown on the Drawings or specified herein. Make adjustments to locations as required by structural conditions and to suit coordination requirements of other trades.

D. Locate switch outlet boxes on the latch side of doorways unless otherwise indicated.

E. Locate outlet boxes, above hung ceilings having concealed suspension systems, adjacent to openings for removable recessed lighting fixtures.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.

3.04 Supports

A. Use stamped steel bridges to fasten flush mounting outlet box between studs. Caddy SGB series or equivalent.

B. Use stamped steel bridges or quick mount box support with far side leg support to fasten flush mounted outlet box to adjacent stud. Caddy SGB or H series or equivalent.

C. Do not use outlet boxes having ears for fastening to studs.

D. Do not fasten boxes to ceiling support wires.

E. Support boxes independently of conduit.

F. Use adjustable steel channel fasteners for gypsum board or plaster hung ceilings. Attach bars to main ceiling runners.

G. Support boxes located above accessible suspended ceilings from structure using rod. Do not attach to the ceiling support runners.

3.05 Adjusting

A. Section 01700 - CONTRACT CLOSEOUT: Adjusting installed work.

B. Adjust floor box flush with finish flooring material.

C. Adjust flush-mounting outlets to make front flush with finished wall material.

D. Install knockout closures in unused box openings.

3.06 Cleaning

A. Comply with requirements of Section 01710 - CLEANING.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

3.07 Commissioning

A. Refer to Section 16970 - ELECTRICAL COMMISSIONING requirements.
B. Insure that box color coding and marking in compliance with Section 16195 - ELECTRICAL IDENTIFICATION requirement

END OF SECTION
SECTION 16120
MANUFACTURED WIRING SYSTEM ACCESS FLOOR

PART 1 – GENERAL

1.01 Description
A. The modular convenience power system ensures the electrification and delivery of power from the power panels to required convenience power equipment. The modular wiring system shall be the Intelligent Floor™/Intelligent Ceiling™ power system manufactured by America Cable Systems, New Bedford, MA, Walker flex underfloor wiring system as manufactured by Wiremold, or approved equal.

1.02 Quality Assurance
A. Codes and Regulations
   1. National Fire Protection Association (NFPA)
      a. California Electrical Code (CEC)
      b. 101, Life Safety Code
   2. Underwriters Laboratories (UL) Stand
      a. UL 183, Modular Wiring Systems
      b. UL 1863, Communications Circuit Association
   3. Also conform to the rules and regulations of the State of California; Title 24 Building Standards Basic Electrical Regulations, NFPA, CBC.

1.03 Submittals
A. Section includes:
   1. Main Distribution Boxes
   2. Secondary Distribution Boxes
   3. Multi-Conductor Home Run Cables
   4. Extender Cables
   5. Whip End Extender Cables
   6. Cable Accessories

B. Submit the following:
   1. Manufacturer’s name, brand name, catalog references for all equipment supplied including UL listings for all system components.
   2. Complete system wiring diagrams for all components including floor plan locations of devices, interconnecting wiring, circuit numbers, home runs and interfaces to equipment furnished by others. Show all soft wiring layout and circuitry.

4. Service information including address of nearest representative.

5. Submittals must be complete. Incomplete submittals will be rejected.

C. Products furnished but not installed under this section:

1. Distribution panels, boxes, fixtures, supporting hardware, and devices are furnished, but not installed under this section.

1.04 Operation and Maintenance Data

A. Maintenance Data

1. A complete replacement parts list shall be provided with the as-built package.

2. Warranty Requirements

a. Installation and all equipment are guaranteed by Contractor and manufacturer for one year from written notification of acceptance by the District.

1.05 Product Delivery, Storage and Handling

A. Deliver, store, handle and install all materials and equipment in such a manner as not to degrade quality, serviceability or appearance.

B. Store materials in secure and dry facility and in original packaging in a manner to prevent soiling, physical damage, wetting or corrosion prior to installation.

C. Materials shall be delivered in the manufacturer's original unopened, protective packages.

1.06 General Requirements

A. The modular power system shall be based on zone wiring architecture. Power system cable management shall be achieved through the use of multi-conductor cables, run from the power panel to pre-wired Main Distribution Boxes. This method shall eliminate individual home run cabling. The Main Distribution Boxes shall branch out to feed Secondary Distribution Boxes in a hierarchy. From zone locations, factory-sized prefabricated multi-conductor extender cables shall send power to any point where convenience power is required.

B. The modular power system shall be in accordance with NEC Article 604 and all applicable UL standards. All components shall be labeled with both voltage ratings and installation information. The system shall be designed and keyed to prevent mismatching of different voltages. All devices and wiring shall be rated for 20 amperes.

C. The connector-grounding pin on each modular assembly shall be so designed that the grounding connection is made prior to the contact made within the current carrying conductors per NEC 41 Q-58d.

PART 2 – PRODUCTS

2.01 Access Floor – Modular Wiring System 16xx0 – 10.1 Home Run Cable

A. The cable shall be metal clad cable (type "MC") consisting of multiple #10 AWG, THHN 90°C insulation. The cable type shall be UL listed and recognized as outlined in Article #334 of the latest edition of National Electrical Code.

B. The cable can be equipped with super neutral conductors of # 8AWG, if required, for isolated-ground circuits.
2.02 Main Distribution Box

A. A Main Distribution Box (MDB) with multiple ports (per project requirements) shall provide general-purpose and isolated ground 3-phase, 120/208 volts power. The MDB shall include a home run as specified below. Ground conductors shall be added as required by National Electrical Code (NEC). An insulated green with yellow stripe grounding conductor shall be installed in the cable when an isolated-ground system is required.

B. The MDB shall be constructed of cold-rolled steel conforming to ASTM A596. Minimum thickness shall be 16 gauge or 0.060+/−0.005, with powder-coated finish, tamper proof screwed covers, and four leg mounting supports. The 5- or 10-pin bulkhead connectors shall be secured by rivets. Output ports can be single or double port configurations.

C. Each MDB shall be equipped with a mechanical type grounding lug for attachment of the equipment grounding conductor. The equipment grounding conductor shall be extended to each connector housing and connected to each ground pin position.

D. The MDB shall be UL-listed and identified as such on each cover. The MDB shall be acceptable for use in air-handling spaces other than ducts or plenums in accordance with NEC 300.22(c). Compliance with this requirement shall be marked on the cover.

E. Each cover of the MDB shall have a label indicating the circuit number at each bulkhead connector.

2.03 Secondary Distribution Box

A. A Secondary Distribution Box (SDB) with multiple ports (per project requirements) shall provide general-purpose and isolated-ground 3-phase, 120/208 volts power. Ground conductors shall be added as required by National Electrical Code (NEC).

B. The SDB shall be constructed of cold-rolled steel conforming to ASTM A596. The 5- or 10-pin bulkhead connectors shall be secured by rivets. Output ports can be single or double port configurations.

C. Each SDB shall be equipped with a mechanical type grounding lug for attachment of the equipment grounding conductor. The equipment grounding conductor shall be extended to each connector housing and connected to each ground pin position.

D. The SDB shall be UL listed and identified as such on each cover. The SDB shall be acceptable for use in air-handling spaces other than ducts or plenums in accordance with NEC 300.22(c). Compliance with this requirement shall be marked on the cover.

E. Each cover of the SDB shall have a label indicating the circuit number at each bulkhead connector.

2.04 Extender Cables

A. Extender cables, as required, shall interface with the Main Distribution Box and feed to the Secondary Distribution Boxes.

B. Extender cables shall be type "Me" consisting of 90° C insulated, #12 AWG solid copper conductors, accompanied by a #12 AWG solid copper ground conductor.

C. The extender cable shall have line side (power out) and load side (power in) connectors. The connectors shall be capable of having 5 pins for the distribution of 3-phase, 4 wire, 120/208 volt general-purpose power or 10 pins for the distribution of both 3 phase, 4 wire, 120/208 volt general-purpose and isolated-ground power.

D. The contacts shall be male pin and female receptacle type with minimum conductivity of .60.
E. The plastic that encases the contacts shall have UL standard rating of 94V2. The plastic shall be keyed.

F. The plastic shall be color coded to identify voltage and use.
   1. 120/208V General-purpose Power
   2. Orange - 120/208V Isolated-ground Power
   3. Blue - 120/208V Emergency Back Up Power

G. The latching mechanisms shall be of a different design so that engagement of dissimilar voltages is not possible.

H. Labels shall be permanently attached to both the load (power in) side connector and the line (power out) side connector. The labels shall be color coded to differentiate the general-purpose power and the isolated-ground power.

2.05 Whip End Extender Cables

A. Whip end extender cables shall extend from the Secondary Distribution Boxes to individual convenience power modules.

B. Whip end extender cables shall be type "MC" consisting of 90°C insulated, #12 AWG solid copper conductors, accompanied by a #12 AWG solid copper ground conductor.

C. The whip end extender cable shall have a load side (power in) connector. The connector shall be capable of having 5 pins for the distribution of 3-phase, 4 wire, 120/208 volt general-purpose power or 10 pins for the distribution of both 3-phase, 4 wire, 120/208 volt general-purpose and isolated-ground power. The line side (power out) conductors extending into the convenience power module for hardwire connection shall be eight inches in length.

D. The contacts for the load side (power in) shall be male pin type with minimum conductivity of 60% IACS (International Annealed Copper Standard). The contacts shall be manufactured of .016 tinned copper alloy #194.

E. The plastic that encases the contacts shall have UL94 flammability rating of V2. The plastic shall be keyed differently to prevent mismatching of voltages.

F. The plastic shall be color coded to identify voltage and use.

G. The latching mechanism shall be of a different design so that engagement of dissimilar voltages is not possible.

H. A label shall be permanently attached to the load side (power in) side connector. The label shall be color coded to differentiate the general-purpose power and the isolated-ground power.

2.06 Custom Products

A. The Main Distribution Box and Secondary Distribution Box described in the Standard Products section shall also be available as customized products. These units shall be deliverable with a size and port count capacity different from the standard capacities. The associated horizontal cabling shall be provided to support the customized product.

PART 3 – EXECUTION

3.01 General

A. Install the complete modular wiring system in accordance with manufacturer's recommendations and system design drawings. Coordinate with the general contractor or owner so as not to interfere with other work in
SECTION 16150
RACEWAY AND EQUIPMENT GROUNDING

PART 1 – GENERAL

1.01 Description
   A. Description: Work specified in this section includes all grounding for electrical system raceways, boxes and equipment.

1.02 Quality Assurance
   A. Codes and Regulations:
      1. General: Per requirements in Section 16010.
      2. Approvals: All products shall be UL listed and labeled.

1.03 Submittals
   A. Product Data: Per requirements in Section 16010.

PART 2 – PRODUCTS

2.01 Materials
   A. Wire and Cable: Copper, in all cases. Sizes per NEC. Insulation, where specified, shall be 600 volt.
   B. Connectors on Wires and Cables: UL listed and labeled, copper mechanical connectors.
   C. Ground Rods: 3/4" diameter, "Copperweld," UL approved, ITI "Weaver" manufacturer or equivalent; 8’ minimum length.
   D. Grounding Studs Flush in Floor: Russell and Stoll Catalog No. GCC-1 bronze grounding receptacle with grounding connections and cover. Install with top flush with finished floor. Ground conductor shall be bolted or welded to underside body of the receptacle housing.

PART 3 – EXECUTION

3.01 General
   A. Miscellaneous Ground Connections: Connections shall include all connections required by code and the following:
      Transformer cases.
      Conduit and EMT.
      Switchboard ground bar.
      The secondary bus gutter.
      All motors.
      Distribution centers and panelboards.
      Miscellaneous ground such as cabinets, raceways, etc.
B. Installation of Ground Conductors: Install concealed throughout finished areas. Provide conduit, where necessary, to run through concrete or masonry. Retain accessibility for all connectors. Where exposed in utility spaces, draw tightly against building surfaces.

C. Motors and Equipment Connections: A green wire ground system shall be provided across flexible connections to all motors and control equipment.

D. Connections to building structure shall include Burndy Type CB1 “Thermomold” cable lugs bolted to Burndy “Threaded Studs” Type RS1, welded to the structural flange 19” above floor slab; with ground grid cables installed in 2” conduits for mechanical protection, from underside of slab to point 12” above slab. Spare stud shall be provided at each connection to structural member for future equipment connection.

E. Ground conductors shall be provided paralleling each feeder and branch circuit, installed in same conduit throughout all new work. These wires are in addition to wire quantity shown on Drawings. Increase conduit size where required to accommodate these wires.

F. Pre-Drilling for Ground Rods: If consistency of the soil where ground rods are to be driven does not permit driving the rod without deforming the rod, drill ahole the same diameter as the rod, 2/3 the rod length, and drive the rod the remaining distance. Resistance at each rod, not over 25 ohms; if over, provide additional rods to reduce the total resistance to the required amount. Ground rod shall be interconnected to provide a ground connection not over 0.5 ohms.

G. Underground Connections: Made with connectors using the Cadweld process, or 40 ton compression connectors, Burndy manufacturer. Brazed connections made using manganese or tobin bronze filler are acceptable.

H. Ground Studs on Structural Steel Columns: Welded type Cadweld or equivalent, approved by the Architect and Structural Engineer.

I. Tests of ground system shall be made at completion. Record measurements for each ground rod position. Interconnections between ground rod positions shall be the ground buses. Submit two copies of data to the Architect for approval, and a record of the result shall be included in the Maintenance Manual.

J. Obtain isolated ground at the same point where low voltage system neutral feeding the circuits is grounded.

END OF SECTION
PART 1 – GENERAL

1.01 Summary
   A. Grounding electrodes and conductors.
   B. Equipment grounding conductors.
   C. Bonding.

1.02 References
   A. CEC - California Electrical Code.

1.03 Grounding Electrode System
   A. Metal underground water pipe.
   B. Metal frame of the building.
   C. Concrete-encased electrode.
   D. Metal underground gas piping system.
   E. Rod electrode.

1.04 Performance Requirements
   A. Grounding System Resistance: 5 Ohms.

1.05 Quality Assurance
   A. Comply with requirements of CEC.
   B. Furnish products listed and classified by Underwriters Laboratories, Inc. As suitable for purpose specified and shown.

PART 2 – PRODUCTS

2.01 Acceptable Manufacturers
   A. Burndy
   B. Cadweld
   C. Lisco
   D. OZ/Gedney
   E. Or equivalent.
2.02 Rod Electrode
   A. Material: Copper.
   B. Diameter: 3/4 inch.
   C. Length: 10 feel

2.03 Mechanical
   A. Material: Bronze

2.04 Wire
   A. Material: Stranded copper.
   B. Foundation Electrodes: 4/0 AWG.
   C. Grounding Electrode Conductor: Size to meet CEC requirements.
      1. Use green THW/THWN insulated copper wire. For conductors that are not commercially available with green insulation; identify using green plastic tape in accordance with Section 16195 ELECTRICAL IDENTIFICATION and CEC.

2.05 Grounding Well Components
   A. Ground Well: 8-inch diameter, 12-inch deep, precast concrete well.
   B. Well Cover: Cast iron with legend “GROUND” embossed on cover.

2.06 Insulated Grounding Bushings
   A. Plated malleable iron body with molded plastic insulating throat and lay-in grounding lug. OZ/Gedney BLG series or equivalent.

2.07 Connections to Pipes
   A. For cable to pipe, OZ/Gedney G-1090B or equivalent.

2.08 Bonding Jumpers
   A. OZ/Gedney Type BJ or equivalent.

2.09 Main building Reference Ground Bus
   A. Provide one 24-inch wide by 4-inch high by 1/4-inch thick copper bus bar, or size as noted on drawings. Mount on walls in locations shown, on insulating standoffs, 18-inches above finished floor unless otherwise indicated. Furnish complete with cast copper allow body lugs for connecting grounding system cables. Attach lugs to bus with appropriate size bronze bolt, flat washer and Belleville washer. Torque all connections. Drill and tap holes for single hole lugs. Provide 6 spare lugs and lug spaces.

PART 3 – EXECUTION

3.01 Examination
   A. Verify that final backfill and compaction has been completed before driving rod electrodes.
3.02 Installation

A. Install products in accordance with manufacturer’s instructions.

B. Install rod electrodes at locations indicated.

C. Provide ground well with cover at each rod location. Install well top flush with finished grade.

D. UFER Ground: Install 4/0 AWG bare copper wire in exterior concrete foundation footing. Provide minimum 20-foot length of conductor cast into the bottom 6-inches of a foundation or footing.

E. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing. Bond steel together either by welding or exothermic connections. Bond steel located within 20-foot distance from ground conductor connection point. Perform welding in accordance with Section 03200 – CONCRETE REINFORCEMENT instructions.

F. Provide bonding to meet regulatory requirements.

G. Grounding conductor connectors: Made up tight and located for future servicing and to insure low impedance.

H. Ground the cold water service and the structural steel to the main electrical ground system.

I. All plug-in receptacles: Bond to boxes, raceways and grounding conductor.

J. Use the same size equipment ground conductors as phase conductors, up through 10 AWG.

K. Provide grounding pigtails for bonding metal boxes to the ground system. Use minimum 12 AWG, insulated green conductor.

L. Equipment grounding conductor: Provide separate, insulated copper conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus or bushing.

M. Install Reference Ground Bus Bars in electrical equipment rooms. Bond bars to main electrical ground system using 4/0 AWG copper conductor. Route conductor in rigid metal conduit. Bond conduit to ground system.

N. Provide PVC conduit sleeves for bare conductor pigtails penetrating concrete slabs. Use conduit size as required for conductor size.

O. Use exothermic weld kits for below grade conductor splices and foundation steel connections. Use bolted connectors for above grade terminations. Use compression connectors to exothermic weld kits for above grade splices.

P. Apply corrosion inhibitor to mechanical or compression lugs before making conductor terminations. Burndy Pentrox or equivalent.

Q. Bond together metal siding not attached to grounded structure; bond to ground.

R. Bond together reinforcing steel and metal accessories in pool and fountain structures.

S. Provide isolated grounding conductor for circuits supply electronic cash registers and as shown on drawings.
3.03 Equipment
   A. Ground all fixtures, exterior lighting standards, panels, controls, motors, disconnect switches, kitchen equipment and other equipment enclosures. Use bonding jumpers, grounding bushings, lugs, buses and other approved bonding devices for connection to the ground system.
   B. Bond transformers and similar equipment to main electrical ground system by using the Reference Ground Bus Bars.
   C. Bond all equipment ground buses to the main electrical ground system.

3.04 Communication System Grounding
   A. Provide ground bus bars as indicated. Bond bars to structural steel or main ground system using at 6 AWG conductor. Route conductor in conduit.
   B. Provide a ground termination at each satellite communication room backboard. Use a 6 AWG conductor. Route in conduit and bond to structural steel or main ground system.

3.05 Commissioning
   A. Refer to Division 1 and 16970 - COMMISSIONING.

3.06 Performance Verification
   A. Refer to Section 16950 - TESTING REQUIREMENTS for system testing requirements.

END OF SECTION
SECTION 16195
ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.01 Description
A. Provide all labor, materials and equipment necessary to complete the installation of:
   1. Nameplates.
   2. Wire and cable markers.
   3. Panelboard directories.
   5. Coverplate labeling.

1.02 Related Sections
A. Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
B. Section 16010: Electrical General Provisions.

1.03 Submittals
A. Provide all submittal information in accordance with the requirements of Section 16010: Electrical General Provisions.
B. Provide data sheets for all devices furnished under this Section.
C. Provide schedules for nameplates to be furnished.

PART 2 – PRODUCTS

2.01 Nameplates
A. Type NP: Use engraved three-layer laminated plastic, with black letters.
B. Provide all nameplates white.
C. Provide nameplate and letter sizes as specified in Part 3 – Execution.

2.02 Legend Plates
A. Type LP: Use die-stamped metal legend plate with mounting hole and positioning key.
B. Engraved characters to be paint-filled.

2.03 Panelboard Directories
A. Provide typewritten directories arranged in numerical order showing the number of the room in which each device
served by each panelboard circuit is located.

B. Verify the room numbers to be used with the Owner. Room number will not necessarily be those used on the Drawings.

C. Mount directories in a 6” by 8” metal frame under a clear plastic cover inside each panelboard door.

2.04 Wire and Thermal Markers

A. Provide self-adhering, pre-printed, self-laminating vinyl wrap-around strips.

B. Use Thomas & Betts WSL, Brady B191 series, or equal.

2.05 Conductor Phase Marker

A. Provide colored vinyl plastic electrical tape to identify conductor phases.

B. Use Scotch 35 Brand tape or equal.

2.06 Wiring Device Covers

A. Circuit cover plates shall have thermal labeling - Kroy Duratype process small letter height, designating controlled equipment or specific load and shall bear panelboard designation and circuit breaker number serving device. Switches controlling remote or special equipment shall also bear such information and controlled device by engraved means only. Submit 2 samples of specified plates with identification for Architect’s approval.

1. Thermal Labeling System:

   a. Thermal labeling using the Kroy Duratype 240-SE or 224 SE labeling system is acceptable.

   b. Labeling the cartridge shall be exterior grade for industrial labeling environments. Other cartridge types are not acceptable.

   c. Colored tape for different system device cover shall be:

      (1) Black letters on clear background.

   d. Provide Owner with one Kroy Duratype 240 SE or 224 SE labeling machine complete with AC power adapter, nickel cadmium battery charger, and 2 industrial labeling cartridges of each color tape combination noted above.

2.07 Underground Conduit Markers

A. Provide 6” wide, yellow polyethylene tape with continuous black imprinting reading “Caution - Buried Electric Line Below.”


PART 3 – EXECUTION

3.01 Installation

A. Degrease and clean surfaces to receive nameplates.

B. Install nameplates parallel to equipment lines.
C. Secure nameplates to equipment fronts using machine screws. Secure nameplate to inside face of recessed panelboard doors in finished locations.

D. Do not use embossed tape for any application.

E. Mount panelboard directories in a 6" x 8" metal frame under a clear plastic cover inside every panelboard.

F. Nameplate designation in accordance with Drawings.

1. Nameplates provided for:
   a. Disconnect switches.
   b. Circuit breakers.
   c. Switchboards.
   d. Panelboards.
   e. Transformers.
   f. Cabinets.
   g. Motor controllers.
   h. Time switches.
   i. Contactors.

3.02 Wire Identification

A. Provide wire markers on each conductor in panelboard gutters, pullboxes, outlet and junction boxes and at load connection. Identify with serving panel or device and branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

B. Provide conductor phase markers as noted in Section 16050 Basic Materials and Methods.

3.03 Box Identification

A. Clearly mark all pull and junction box cover plates for the lighting and receptacle branch circuit systems with a permanent ink felt pen identifying the branch circuit (panel designation and circuit number) contained in the box.

B. Use black marker for "normal" circuits, and red marker for "emergency" circuits.

3.04 Nameplate Engravings

A. Provide type "NP" nameplates with minimum letter height as noted below.

B. For Panelboards, Distribution Boards, Switchboards, Battery Panels and Motor Control Center: \( \frac{3}{8} \)" letters to identify equipment designation. Use \( \frac{11}{16} \)" letters to identify voltage rating and ampere rating.

C. For individual circuit breakers, switches and motor starters in panelboards, distribution boards, switchboards and motor control centers, use \( \frac{3}{8} \)" letters to identify circuit, load served, feeder overcurrent device size, and feeder cable size.

D. For individual circuit breakers, disconnect switches, enclosed switches, and motor starters, use \( \frac{3}{8} \)" letters to
identify load served, feeder overcurrent device size and feeder cable size.

E. For transformers, use 3/8" letters to identify equipment designation. Use 1/8" letters to identify primary and secondary voltages, kva rating, panel feeder primary and load being served.

F. For equipment cabinets, terminal cabinets, control panels, lighting control panels, and other cabinet enclosed apparatus, use 3/16" letters to identify equipment designation.

G. Provide type "LP" metal legend plates for attachment to panel mounted operators, devices such as pilot lights, reset buttons, hand-off-auto switches, etc.

END OF SECTION
SECTION 16410
HARMONIC MITIGATION DEVICE

PART 1 – GENERAL

1.01 References

A. This section covers the specification of three-phase Harmonic Suppression System for phase to neutral connected loads with integral dry type transformers.

B. Refer to Sections 16010, 16050, GENERAL CONDITIONS and SUPPLEMENTARY GENERAL CONDITIONS and other applicable sections for other general requirements.

1.02 Related Documents

A. Instructions to Bidders, A.I.A Document A201, "The General Conditions of the Contract for Construction", latest edition, the Supplementary General Conditions, and Division 1 General requirements are a part of this Section and shall be binding on the Contractor and/or Subcontractor who performs this work. Note also all Addenda.

1.03 Scope

A. Provide labor, materials, equipment, services and transportation necessary for complete and operational systems as shown on the Contract Drawings and specified herein, including, but not limited to, the following:

1. Transformer based Harmonic Suppression System
2. Grounding of transformer and HSS
3. Start-up of transformer and HSS

B. It is the intent of this section to provide low frequency harmonic suppression integral to a three phase, 3-wire primary, 3-phase, 4-wire secondary, dry type distribution transformer with features, ratings and options as specified herein:

1. HSS shall be a passive device to be installed at the secondary of a wye connected distribution transformer at a voltage of 208/120 and at a frequency of 60Hz. The HSS shall reduce the 3rd harmonic current flowing in the phase wires and the neutral wire from the transformer to the furthest outlet.

1.04 Submittals

A. Submit for review and approval, shop drawings and other requested information for the following equipment:

1. Transformer
2. Harmonic Suppression System

B. Shop drawings shall include the following information:

1. Product specification sheets
2. Product dimensional data
3. Delivery, installation and testing information
4. Wiring and interconnection diagrams
5. Schedule of proposed shut downs if required

C. Submit shop drawing and other submittals per the requirements of applicable specification sections.

1.05 Standards

A. All work of this section shall conform to the following standards:
   1. National Electrical Code, NFPA 70
   2. Applicable State and local Codes
   3. Applicable ANSI Standards
   4. Applicable IEEE Standards
   5. Applicable NFPA Codes and Standards
   6. Applicable NEMA standards

1.06 Product Listings

A. Equipment, materials and components for which there are UL, ETI, CSA approvals shall bear the appropriate labels.

B. The specified units shall be designed, manufactured, and tested in accordance with one or more of the following standards:
   1. Underwriters laboratory, UL, 508A
   2. Canadian Standards Association, CSA, Equivalent

1.07 Quality Assurance

A. Install all equipment in accordance with National Electrical Code and all applicable regional and local codes.

B. All products shall be manufactured in the USA by a company engaged in the commercial design and production of HSS for a minimum period of 10 years.

1.08 Performance Specification

A. The HSS shall be totally passive in operation and shall not contain any electronic switching devices such as transistors, SCRs, etc.

B. The HSS shall be entirely self-contained in its own enclosure and shall not require any external enclosures.

C. The HSS shall consist of a single unit per transformer in a three-phase wye connected power system.

D. The HSS will be operative to remove harmonic currents on all three phase wires and the neutral wire of a power system loaded with single-phase non-linear loads connected phase to neutral.

E. The HSS shall be protected by the same fuses or circuit breakers that protect the phase wires for the transformer and shall not require any separate fusing for protection.
F. The HSS shall be capable of handling the full rated load of the transformer, and shall not require resizing as the transformer is loaded to its full capacity with non-linear loads.

G. The HSS shall block the flow of harmonic current of the frequency, 3rd harmonic of the fundamental (180Hz in the case of a 60Hz fundamental).

H. The HSS shall reduce 3rd harmonic current flow, measured at the secondary of the transformer, in each of the three phase wires from the transformer out to the furthest outlet.

I. The HSS shall reduce rms current flow, measured at the secondary of the transformer, in each of the three phase wires from the transformer out to the furthest outlet.

J. The HSS shall reduce 3rd harmonic current flow, measured at the secondary of the transformer, in the neutral wire from the transformer out to the furthest outlet.

K. The HSS shall reduce rms current flow, measured at the secondary of the transformer, in the neutral wire from the transformer out to the furthest outlet.

L. The reduction of harmonic currents in the phase wires and neutral shall result in increased system capacity to power useful loads.

M. In the event that each circuit consists of a phase wire and an individual neutral wire to each load, the HSS shall reduce 3rd harmonic current flow in every neutral wire in the entire distribution system, from the secondary of the transformer out to the furthest load.

1.09 Sequence/Schedule

A. All proposed interruptions of existing electrical services to critical loads shall be reviewed and approved by the Owner's representative.

B. Coordinate scheduled interruptions of electrical service with all concerned parties prior to beginning work.

1.10 Warranty

A. Unless otherwise specified, all equipment specified herein is warranted to be free of defects in materials and workmanship under normal use and service for a period of five years from the date of purchase.

1.11 Substitutions

A. The preferred supplier for these products is Harmonics Limited, Brookfield, CT, 877-437-3688. Proposed product substitutions shall be accompanied by a fully completed compliance review, documenting that the proposed substitution is in full compliance with all 13 items (1.8, A-M) of the performance specification. Substitutions that are not fully compliant with all requirements of the 13 specifications shall be deemed unacceptable.

PART 2 – PRODUCTS

2.01 Transformer Based Harmonic Suppression System

A. Description

1. Harmonic suppression system shall consist of a three-phase, 3-wire primary, 3-phase 4-wire secondary, dry type transformer with a series connected neutral harmonic suppression system which are factory wired and enclosed in a NEMA 1 construction.

B. Transformer Harmonic Suppression System performance ratings shall be as follows based on 208-volt
C. Dry type distribution transformer shall have the following characteristics and features:

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<th>MODEL</th>
<th>FULL LOAD Kva</th>
<th>RATING IN AMPS</th>
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<td>42</td>
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<tr>
<td>HLBNX030-F2IF7</td>
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</table>

1. kVA rating    As indicated on drawings
2. Input voltage  480 volt delta
3. Output voltage 208 volt, 3-phase, 4 wire, wye
4. Insulation class 220 degree C
5. Temperature class 115 degree C rise
6. Mechanical    Core and coil
7. Winding material Copper
8. Electrostatic shield Yes
9. Taps          2x 2.5% FCAN and 4 x 2.5% FC
10. Enclosure    Type 1

PART 3 – EXECUTION

3.01 Installation of Transformer Based Harmonic Suppression System

A. Confirm voltage, kVA rating, and frequency of device with load and building distribution system characteristics prior to installation.

B. Coordinate exact locations and mounting of device with Architect/Owner/Owner’s Representative/other trades prior to installation.

C. Provide mounting or seismic restraints as required by local codes if any.
D. Make sure that the system on to which the HSS is to be installed is de-energized before starting installation.

E. Install per manufacturer's written instructions making sure to implement proper wiring and grounding.

3.02 General Wiring Tests

A. Prior to energizing the device, verify the following:

1. System voltage and frequency are correct
2. Devices are properly rated for loads being served
3. Wiring is in full compliance with manufacturer's instructions
4. Primary and secondary over current protective devices are installed per codes.

END OF SECTION
SECTION 16500
LIGHTING

PART 1 – GENERAL

1.01 Related Documents
A. Drawings, Construction Services Agreement, including General and Special Conditions and Division-1 Specification Sections, apply to work specified in this Section.

1.02 Description
A. Work Included in This Section: Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:
   1. Lighting fixtures (luminaries).
   2. Components
   3. Lamps.
B. Related Work in Other Sections:
   1. Section 16050, Basic Materials and Methods.
   2. Wall and ceiling types, Finishes, Division 9.
   3. Section 16510, Lighting Controls

1.03 Incorporated Documents
A. Published specifications, standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:
   1. CBM - Certified Ballast Manufacturers.
   2. ETL - Engineering Testing Laboratories
   3. IES - Illuminating Engineering Society
   4. NEMA - National Electrical Manufacturer’s Association
   5. UL - Underwriters’ Laboratories, Inc.

1.04 Quality Assurance
A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
B. Supply all equipment and accessories new, free from defects and listed by Underwriters' Laboratories, Inc., or bearing its label.
C. Supply all equipment and accessories in compliance with the applicable standards listed in this Section and with all applicable national and state codes.
D. All items of a given type shall be the products of the same manufacturer.

1.05 Submittals

A. Submit the following to the Architect:

1. Manufacturer’s name, brand name, and catalog reference of equipment supplied.
2. Details of construction and finishes of fixtures.
3. Drawings: To scale (indicate scale).
4. Photometric data, including optical performance rendered by independent testing laboratory developed according to IES Methods, as follows:
   a. For Down and Semi-Down Lights Used for General Illumination:
      (1) Coefficients of utilization.
      (2) Visual comfort probability data (fluorescent only) for 100 foot-candle (1000 lux) room with reflectance’s of 80% (ceiling), 50% (walls), and 20% (floor), including a 20’ x 20’ (6m x 6m) room with 10’ (3m) ceiling and luminaries lengthwise.
      (3) Candlepower data, presented graphically and numerically, in 10 degree increments (5 degrees, 15 degrees, etc.). Data developed for up and down quadrants normal, parallel, and at 45 degrees to lamps if light output is asymmetric.
      (4) Zonal lumens stated numerically in 10 degree increments (5 degrees, 15 degrees, etc.) as above.
   b. For Other Fixtures: Candlepower curves, presented graphically and numerically, in 10 degree increments (5 degrees, 15 degrees, etc.) or smaller increments for narrow-beam fixtures.
   c. For Area and Roadway Luminaries: Isocandela charts, coefficients of utilization, and IES roadway distribution classifications.
5. Fixture Lists: Submit list of fixture types and quantities, including specific lamp(s) provided with each fixture.
6. Seismic requirements in accordance with the State of California codes.

1.06 Product Delivery, Storage, And Handling

A. Ship equipment in its original packages to prevent damage or entrance of foreign matter. All handling performed in accordance with manufacturer’s recommendations. Provide protective coverings during construction.

B. Replace, at no expense to Owner, equipment or material damaged during storage or installation as directed by the Architect.

1.07 Guarantee

A. Guarantee of all equipment and labor by manufacturer for one year from written notification of acceptance by the Owner.
PART 2 – PRODUCTS

2.01 General

A. Type of fixtures indicated by letter/numbers, ie. F1, F2 etc.. See Fixture Schedule on the Drawings for description of fixture types.

B. Incandescent: 130 volt lamps, except as noted.

C. Fluorescent: 120 or 277 volt, energy saving type lamps, except as indicated.

D. High Intensity Discharge: 120 or 277 volt, except as noted.

E. Sheet Metal Fixture Housings: Welded construction, with exceptions noted under fixture types.

F. Fixtures with baffles riveted or welded to housing not acceptable.

G. Fixture catalog numbers used to illustrate equipment type do not necessarily denote required mounting equipment or accessories. Provide accessories to suit.

H. Chains, Springs, Hinges or Other Fastening Devices Required on Apertures, Reflectors and Baffles: Removable from fixture housings.

2.02 Fixture Construction

A. Free of light leaks.

B. Ventilation For:
   1. Lamps.
   2. Ballasts.

C. Outdoor Fixtures: Provide approved wire mesh screens for ventilation openings, as required.

D. Weatherproof and Vaportight Fixture Finishes: Weatherproof enamel, galvanized or epoxy, including hangers.

E. Certified by manufacturer to comply with California Energy Commission requirements.

2.03 Lamp Holders

A. Incandescent:
   2. Socket Nickel-plated brass, prelubricated with silicone compound.

B. Fluorescent:

C. High Density Discharge:
2. Socket: Nickel-plated brass, prelubricated with silicone compound.

2.04 Ballasts

A. General:
   1. High power factor, including compact fluorescent ballasts.
   2. Of required voltage and frequency.

B. Fluorescent:
   1. Rapid start, electronic energy saver type, except as noted, similar to Advance Mark V Integrated Circuit Ballasts .90 power factor or higher for all ballasts, including compact fluorescent. Total harmonic distortion shall be below 1.5%.
   2. NEMA "A" rated noise level. Replace noisy ballasts at no cost to Owner, as directed.
   3. Class P with internal resetting thermal protector for core and coil and non resetting protector for capacitor.
   5. Mount lamps on rapid-start circuits within 1" (25mm) of grounded metal, minimum 1" (25mm) wide, as long as lamp.
   6. Dimming Ballasts: See section 16920 for lab and classroom dimming ballasts. All others shall be Lutron Hi-Lume. Ensure ballast slide dimmer compatibility.

C. High Intensity Discharge:
   1. Encased and potted where subject to moisture.
   2. For Indoor and Non-Weatherproof Use: UL listed encapsulated Type 1. For Outdoor Use: UL listed Type 2.
   3. Constant wattage auto-transformer or constant wattage type.
   4. Suitable to operate within plus or minus 10% voltage variation.
   5. Drop-Out Voltage: 66% of nominal.
   6. Insulation: Class H, 375 degrees F (180 degrees C).

D. Ballasts approved for operating with standard and energy saving lamps.

2.05 Contact Surfaces

A. Aluminum to Bronze: Coating equal to Minnesota Mining and Manufacturing Co. No. 1706, "Coro-Guard", applied to both surfaces.

B. Aluminum to Concrete: Coating of polyurethane base paint, similar to Lehman Bros. "OxO-Deck", or asphaltum.
2.06 Wiring

A. 120/208 Volt Luminaire Wiring: 300 volt, 302 degrees F (150 degrees C), Type AP or SFF, beginning at separately mounted outlet box.

B. 277/480 Volt Luminaire Wiring: 600 volt, 220 degrees F (105 degrees C). Appliance Type AWM or THHN, beginning at separately mounted outlet box.

C. Splices: Mechanical spring pressure connector or crimp connector.

D. Minimum 3/8” (9.5mm) flexible conduit connections for recessed fixtures, except as indicated. Maximum length 6’-0” (1.85mm).

2.07 Supports

A. Individual Fixtures: Carry weight of fixture to building structure construction, clear of ducts or pipes.

B. Recessed Fluorescents: With yokes or lugs and leveling provisions.

C. Recessed Incandescent and H.I.D: With structural members and leveling provisions.

D. Pendant Mounted Fixtures: With conduit stems or steel cables supported to structural framework. Self-leveling fittings.

2.08 Finishes

A. Painted Surfaces, Except As Noted:

1. Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350 degrees F (177 degrees C) minimum, catalytically or photochemically polymerized after application.

2. White Finishes: Minimum of 85% reflectance.

3. Metal Parts: Cleaned and treated with phosphate or chromate bonding process after fabrication for maximum paint adhesion.

B. Unpainted Aluminum Surfaces:

1. Satin anodized, except as noted.

2. Indoor locations to meet Aluminum Association standards for outdoor coatings.

C. Plastic Lenses and Diffusers: Destaticize.

D. Reflectors and Baffles: Free of marks, labels or blemishes.

PART 3 – EXECUTION

3.01 Installation of Lighting Fixtures

A. Locations:

2. Verify with Architectural Reflected Ceiling Drawings.

3. Coordinate space conditions with other trades.

4. In mechanical equipment or similar rooms without finished ceilings, modify locations and mounting to suit conditions as directed.

5. Fixture Rows: In straight lines except as noted.

6. Pendant or Surface Mounting: As noted.

B. Mounting:

1. Ceiling Construction:
   a. Refer to Architectural Drawings for finish schedules. Provide fixture with mounting hardware to suit ceiling in which fixture is to be installed.
   b. Refer to manufacturer's installation details and applicable codes for required fixture mounting accessories and to accommodate actual ceiling construction.

2. Recessed in Plaster Ceilings:
   a. Provide Plaster Frames:
      (1) For setting, under General Construction Work.
      (2) With bottom of frames flush with finished ceiling and forming screened edge.
      (3) Individually Pendant Mounted Units: With canopies for pendants and junction box at the ceiling line for each fixture.
      (4) Continuously Pendant Mounted Units: With canopies for pendants and junction box for each continuous run except a noted.

3. Pole Mounted Exterior Fixtures:
   a. Install in accordance with manufacturer's recommendation and stand industry practice.
   b. Provide a reinforced concrete based for all pole and bollard fixtures in accordance with the drawings and/or manufacturer's recommendations. Provide a ground conductor in all bases.
C. Reflector Cones, Baffles, Aperture Plates, Light Controlling Elements for Air Handling Fixtures and Decorative Elements: Install after completion of ceiling tiles, painting and general cleanup.

D. Replace blemished, damaged, or unsatisfactory fixtures and ballasts as directed.

E. Adjustable Fixtures:
   1. Target and focus after regular working hours and before building acceptance
   2. Permanently indicate targeting on fixture and provide positive locking devices to preclude mis-focus during relamping.
   3. Target and focus in presence of Architect.

F. Relamp fixtures immediately prior to Owner's acceptance of building.

END OF SECTION
SECTION 16510
LIGHTING CONTROL SYSTEM

PART 1 – GENERAL
1.01 Introduction
   A. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications.
   B. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system.

1.02 System Description
   A. Install a low voltage switching system consisting of relay panels and intelligent switches connected together by a dataline, as well as all associated wiring.
   B. The system includes a DIN rail-mounted automation module, photocontrol module and/or other low voltage control devices. These devices are totally compatible with the manual operation of the dataline switches.
   C. Requirements are indicated elsewhere in the specifications for work including, but not limited to, raceways and electrical boxes and fitting required for installation of control equipment and wiring.

1.03 Quality Assurance
   A. Manufacturers: Firms regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Manufacturer shall be ISO 9001 certified.
   B. Component Pre-testing: All components and assemblies are to be factory pre-tested prior to installation.
   C. System Support: Factory applications engineers shall be available for telephone support.
   D. NEC Compliance: Comply with NEC as applicable to electrical wiring work.
   E. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
   F. UL Approvals: Remote panels are to be UL listed under UL 916 Energy Management Equipment.
   G. FCC Emissions: All assemblies are to be in compliance with FCC emissions Standards specified in Part 15 Subpart J for Class A application.

1.04 Submittals
   A. Shop Drawings: Submit dimensional drawings of all lighting control system components and accessories.
   B. One Line Diagram: Submit a one-line diagram of the system configuration proposed if it differs from that illustrated in the riser diagram included in the contract drawings.
   C. Typical Wiring Diagrams: Submit typical wiring diagrams for all components including, but not limited to, relay panels, relays, low voltage dataline switches, occupancy sensors and daylighting controls.
1.05 Manufacturers

A. The basis of the specified system is the Smartwired Switching (SWS) System manufactured by The Watt Stopper. Any other system wishing to be considered must submit descriptive information 10 days prior to bid. Prior approval does not guarantee final approval by the electrical engineer. The contractor shall be completely responsible for providing a system meeting this specification in its entirety. All deviations from this specification must be listed and individually signed off by the consultant.

PART 2 – MATERIALS AND COMPONENTS

2.01 Smartwired Switching (SWS) Relay Panels

A. Description

1. Modular Relay Panels shall be UL listed and consist of the following:
   a. Tub: Empty NEMA 1 enclosure that can accept an interior sized to accept up to 12, 24, or 48 mechanically latching relays.
   b. Power Supply: Transformer assembly with two 40VA transformers with separate secondary’s. Transformers include internal overcurrent protection with automatic reset and metal oxide varistor protection against power line spikes. Single unit provides either 115 or 277 VAC as required, 60 Hz +/-10%.
   c. Cover: Surface or Flush as required, with captive screws in a hinged, lockable configuration.
   d. Interior: Bracket and intelligence board backplane with pre-mounted relays. Interiors shall be provided with up to 12, 24, or 48 installed and tested relays.
   e. Panel shall be provided with an integral DIN rail mounting bar for easy installation of other system components (such as a time clock and/or photocell controller). Terminals shall be included in the interior to accept a dataline for the connection of dataline switches to the system, or to allow a dataline to be run between multiple panels for network communications.
   f. Eight channels for grouping relays shall be provided in each interior regardless of size, each with an associated pushbutton to toggle the channel ON/OFF, and a terminal block for a separate dry contact input. Any number of relays in the panel can be assigned to each channel, with overlapping allowed. Channels shall be set up via Smartwiring, i.e. no hand held programmer or keypad is required. Systems that require programmers or keypads, or that change relay states during set up, are not acceptable. Each channel pushbutton shall provide LED status indication: RED shall indicate that all relays within the channel group are ON; NO LED shall indicate that all relays-within the group are OFF, and GREEN shall indicate the channel's relays are in a MIXED state (some OFF, some ON).

B. Features

1. Relays shall be momentary-pulsed mechanically latching contactors with plug in connector. Relays shall have mechanically latching contacts with single moving part design for improved reliability. Relays will have the following characteristics:
   a. Coil
      (1) Magnetically held, momentary coil activation (50 milliseconds).
      (2) 2.2 VA max per relay to allow up to 20 relays to be controlled in parallel using class 2 wiring.
b. Power Contacts

(1) 20 amp tungsten and NEMA electronic ballast rated.
(2) Rated for 50,000 ON/OFF cycles at full load.
(3) Support #10 - #14 AWG solid or stranded wire.
(4) 120,277 and 347 volt rated.
(5) Standard 1 year warranty.

c. 30 VAC Isolated contacts for status feedback and pilot light indication.

d. FCC approved for commercial and residential use.

C. Next to each relay shall be an individual override button and a bi-color LED to indicate status.

D. Panels shall support the “blink warning” function, with LED indication for each relay.

E. Captive screw terminations will be provided for all wiring connections.

F. Each channel button's dry control contact input terminal shall accept either 2or 3-wire, maintained or 6. momentary inputs. They shall also accept a 2-wire toggling input.

G. Each channel shall also have an associated 1 amp, 30 VDC isolated contact which may be used for status feedback or pilot light control.

H. Each panel shall include simple dials for setting a 2-digit panel address.

I. The Relay Panel shall use an EEPROM to record the channel's smartwiring assignments and the current status of all relays, thus insuring a 20-year backup of information in the event of a power failure. Systems that require a chargeable battery with less than 10 year's life shall not be allowed.

J. The unit shall provide LED status indication of the power supply status. Access to 24VAC and 24V rectified power for accessory devices shall be provided within the panel.

K. The panel shall have an integrated DIN rail for mounting dataline control modules.

2.02 Network Dataline

A. Description

1. The intelligence in multiple panels shall be linked over a single dataline that uses the open Echelon/LonTalk@protocol for communications. The dataline shall provide a highly reliable communications bus for transferring control and status between the relay panels. The dataline shall not require any ancillary equipment to function properly.

2. The dataline, in addition to linking together multiple relay panels, shall be capable of extending out from the electrical closet, and provide a single communications bus to allow dataline switches to communicate with the panels.

3. The dataline can also connect to a single Network Clock or a single BMS Interface Module mounted in the interior of a relay panel or a separate enclosure.
B. Features

1. Dataline shall be 18 AWG, 4 unshielded copper conductors (two independent twisted pairs) meeting Class 2P NEC code requirements. The dataline can be run in a loop, serial, or star configuration. Minimum 1 turn per 3 inches; capacitance 30 pF/foot max.

2. Maximum length for all dataline wire in the system is 1,500 feet without repeaters.

3. Maximum number of dataline devices (panels/switch units/controllers) is 64 without a repeater.

2.03 Smartwired Dataline Switches

A. Description

1. To allow individual overrides, dataline switches shall be terminated to each panel's 4-wire Local Dataline. Switches shall be available in single, dual, quad, or octal (1-button, 2-button, 4-button, or 8-button) designs. The single, dual, and quad devices shall mount in a standard single gang box: the octal version in a two gang box.

2. Each button in a switch module can be individually programmed. Programming is done by smartwiring rather than with a handheld keypad or computer. Each button can control anyone of the following options:
   a. Any individual relay in any single panel.
   b. Any group of relays in any single panel.
   c. Any of the eight channels (A-H) in a single panel.
   d. The same channel letter (A-H) in multiple panels in the system (requires Network Clock or BMS Interface Module).

3. For applications that require pattern Switching, any button can perform its function using a ON/OFF/Not Controlled pattern of relays instead of the normal All ON/ALL OFF.

B. Feature

1. Switches shall be constructed of non-breakable Lexan on all exposed parts and shall include a matching screwless Lexan wallplate.

2. Individual buttons shall have a movable clear cover to allow standard 9 mm (3/8 inch) labeling tape to be used to identify the controlled loads.

3. Each switch module shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays. LED indications are Red for All ON, Green for Mixed State (some relays in the group ON and others OFF), and No LED for All OFF.

4. Switch LED pilot lights shall flash green to indicate impending off sweep during the five-minute grace period following blink warning of the lights. Once the button is pressed, the LED will change to Red to acknowledge the occupant's override command to keep lights ON.

5. Multiple dataline switches smartwired to control the same relay or relay group shall indicate the same status automatically.

6. Each switch unit shall also include a locator light.

7. Each switch module is available in Keylock Override version. Once a key is inserted, the individual buttons with function for five minutes.
2.04 NETWORK CLOCK

A. Description

1. Using the same dataline as mentioned above, provide a Network Clock. Network Clock can be used to schedule any of the 8 global channel groups (A-H) in the relay panel network. Schedules are defined using Occupied v. Unoccupied (after-hours) times to simplify data entry.

2. Network shall include user-selectable intelligent scenarios to handle standard lighting control functions for each channel independently, including:
   a. Schedule ON / Schedule OFF
   b. Manual ON / Schedule OFF
   c. Astronomical ON / Astronomical OFF (with user selectable offsets)
   d. Astronomical ON / Schedule OFF (with user selectable offsets)
   e. Manual ON / Multiple OFF Sweeps using Automatic Control Switch.

3. Network Clock shall automatically detect the presence of a dataline Photocontrol Module and alter the Astronomic scenarios to Dark, accepting actual light level readings for the following scenarios:
   a. Dark ON / Dark OFF
   b. Dark ON / Schedule OFF

4. Each channel can be assigned a standard time delay from 1-240 minutes (4 hours). During Occupied hours, the time delays do not take effect. During Unoccupied hours, the time delays will ensure that overridden lights are automatically turned off.

5. Each channel can be assigned an automatic blinking of the lights before they are turned off to allow occupants the opportunity to enter an override without being put in the dark.

6. Network Clock shall include a switch to change its function from Scheduling mode to Programming mode. In programming mode, the unit shall be able to smartwire relays to switch buttons or channels anywhere in the system using simple menus.

7. Network Clock shall include system diagnostic functions to identify devices anywhere on the network dataline.

B. Features

1. Clear 8-line, 22-character per line display and as simple user interface. Takes into account leap year, daylight savings time, and holidays.

2. Provides system diagnostics for all components connected to the system.

3. Allows the user to plug into each dataline switch, run diagnostics, and reprogram the switch to any relay or channel.

4. Retains memory and time for a minimum of 10 years.

2.05 Smartwired Photocontrol Module

A. Description
1. A single photocell shall be mounted in an appropriate location on the roof for measuring exterior light levels. The sensor shall connect to a separate Photocontrol Module mounted on the DIN rail inside any panel via a single 20/4 shielded conductor with a maximum distance of 500 ft.

2. The Photocontrol Module shall connect to any panel via the local dataline, which provides power to the unit. No extra wires shall be required.

3. The Photocontrol Module shall be designed to integrate seamlessly with either the Network Clock or the BMS Interface module. Replacing the astronomic control function on the clock, the Photocontrol module shall measure the actual exterior light level. Each of the eight global channels shall have the ability to be assigned a different trip level.

B. Features

1. Real time, 2-line LCD display of actual exterior light level up to 200 fc.

2. Channel set points and parameters programmed via the Network Clock or BMS Interface Module.

3. Choice of OPERATE or TEST modes, with simulated light level for testing.

4. Control unit detects and broadcasts "Dark" or "Not Dark" states for each channel to the panels.

5. Automatic deadband and 5-minute time delay to avoid nuisance switching.

6. LEDs for each channel show RED if Dark (actual light level below set point); GREEN if above set point, OFF if not programmed.

2.06 Accessory Enclosures

A. Description

1. Provide an Accessory Enclosure with integral DIN rail mounting area and connections for dataline and optional power supply as needed for remote mounting of intelligence modules.

2. Intelligence modules, to include the Network Clock Interface module, shall be simply snapped onto the DIN rail, and their dataline cables connected to a terminal board in the accessory enclosure.

3. Additional power may be supplied if needed by installing a standard dual-transformer power supply in the space provided in the enclosure.

B. Features

1. Enclosure shall be UL listed.

2. Surface mount, with hinged cover and locking latch.

3. Integral DIN rail for remote mounting of accessory modules.

4. Terminal board provides connections for local dataline, global dataline, and accessory power.

2.07 Approved manufacturers

A. The Watt Stopper or approved equal.

1. The contractor shall be completely responsible for providing a system that meets this specification in its entirety. All deviations from this specification must be listed and individually signed off by the consultant.
B. The Watt Stopper catalog numbers.

1. Smartwired Switching System Relay Panels:
   a. Tubs: HTUB12, HTUB24, HTUB48
   b. Power Supply: HPSM115/277
   d. Interiors: HINxx12SS, HINxx12SP, HINxx24SS, HINxx24SP, HINxx48SS, HINxx48SP

2. Network Dataline: HDLW4, HDLW4P (plenum rated)

3. Dataline Switches: HDLS1 SS, HDLS2SS, HDLS4SS, HDLS8SS

4. Network Clock/Programmer: HCLK8SS

5. Photocontrol Module package including photocell: HPCP8SS

6. Accessory Enclosure: HACCBOX

PART 3 – EXECUTION AND SUPPORT SERVICES

3.01 Installation

A. Dataline switches and/or photocells shall be mounted in the spaces as indicated on the Reflected Ceiling Plans. Each low voltage wire shall be labeled clearly indicating which relay panel it connects to. Use only properly color-coded, stranded #18 AWG (or larger) wire as indicated on the drawings. All relays and switches shall be tested after installation to confirm proper operation, and all connected loads shall be recorded on the relay schedule for each panel.

B. The relay panels shall be mounted in electrical closets as indicated on the drawings. The numbered relays in the panel shall be wired to control the power to each load as indicated on the Panel Wiring Schedules included in the drawings. All power wiring will be identified with the circuit breaker number controlling the load. If multiple circuit breaker panels are feeding into a relay panel, wires shall clearly indicate the originating panel's designation.

3.02 Contractor Provided Information

A. Contractor shall provide system documentation after the equipment has been installed:

1. Relay Panels:
   a. Panels shall be numbered consecutively beginning at #01 as shown on the drawings. Individual relay load descriptions and the channels to which they are smartwired shall be recorded on the "SWS Relay Schedule" form provided with each panel.
   b. Intelligent Dataline Switches:
      (1) Each intelligent switch on a relay panel's local dataline shall be numbered consecutively beginning with #01. This switch designation shall be recorded on the label provided on the front of the switch unit, under the wall plate. (For example, the switches connected to relay panel #02 would be numbered 02-01, 02-02, 02-03 etc.) The relays (or channels) controlled by each switch shall be recorded on the "SWS Switch Documentation" form provided with the relay panel.
c. Network Clock (or BMS Interface):

(1) The automation scenarios and operating data for each of the eight channels shall be recorded on the "Network Clock Automation Scenarios" form or "BMS Interface Automation Scenarios" for provided with the Network Clock or BMS Interface Module.

d. System Installation and Operation Manual shipped with the Network Clock or BMS Interface Module shall be provided to the owner.

3.03 System Startup

A. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all system components.

3.04 Training

A. Manufacturer shall provide factory authorized application engineer to train owner personnel in the operation and programming of the lighting control system.

3.05 Documentation

A. Manufacturer shall provide system documentation including:

1. System 1-line showing all panels, number and types of switches and sensors, dataline, and network timeclock or BAS Interface unit.

2. Drawings for each panel showing hardware configuration and numbering.

3. Panel wiring schedules

4. Typical wiring diagrams for each component.

3.06 Warranty

A. Manufacturer shall provide a 1 year warranty for all system components.

END OF SECTION
SECTION 16710

TELECOMMUNICATIONS GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 Section Includes:
   A. Scope of Work
   B. Codes and Specifications
   C. General Requirements and Conditions
   D. Qualifications of Subcontractors
   E. Product Requirements
   F. Structured Cabling System
   G. Submittals
   H. Record Drawings
   I. Definitions

1.02 Related Sections
   A. Contract Terms and Conditions
   B. Section 07270 - Fire Stopping
   C. Section 16715 - Acceptance Testing
   D. Section 16720 - Basic Materials and Methods
   E. Section 16725 - Telecommunications Cable
   F. Section 16730 - Underground Structures – Telecommunications
   G. Section 16740 – Building RF (CATV) Systems
   H. Section 16760 - Telecommunications Grounding and Bonding

1.03 Scope
   A. Scope of Work
      1. The scope of work includes the provision, installation, testing, and documentation of physical resources for voice, data and video systems required by the construction documents. This includes the internal building wiring for the voice, data and video systems and the required support systems and structures as well as connecting the building to the existing campus cabling network as required by the construction documents.
2. The Contractor will provide all labor, materials, tools, equipment, and permits necessary for the satisfactory and timely completion of the project.

3. The Contractor and University shall jointly coordinate the implementation of the project.

4. The scope of work shall include the installation of the inter-building backbone systems including new Pathways, Fiber Optic and Copper Cables for the CSUMB Library as outlined in the specifications and drawings.

5. The work includes, but is not limited to, the items outlined in these specifications and indicated on the drawings, as well as all incidental items required to provide complete and operable systems. The University and the Contractor shall mutually agree on the general conduct for the work prior to initiation of construction and shall each be responsible for following these general guidelines throughout the construction period unless modified in writing based upon discussions at the project coordination meetings.

1.04 Codes and Specifications

A. All work shall be performed in compliance with the most restrictive of Municipal, State, and/or Federal Codes which may govern this work and shall conform to the following codes and specifications:

1. National Fire Protection Association

2. ANSI Specifications:
   b. ANSI C80.3 Specification for Zinc-coated Electrical Metallic Tubing.
   c. ANSI/UL 797 Electrical Metallic Tubing.

3. Electronics Industry Alliance/Telecommunications Industry Association EIA/TIA):
   a. ANSI/EIA/TIA 568-B.1, B.2, B.3 - Commercial Building Telecommunications Wiring Standard.
   b. EIA/TIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
   c. EIA/TIA 606A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
   e. EIA - 310-D - Cabinets, Racks, Panels, and Associated Equipment.
   f. EIA/TIA 526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
   g. EIA/TIA 455-57A - Optical Fiber End Preparation and Examination.
   h. EIA/TIA 455-59 - Measurement of Fiber Point Defects Using and OTDR.
   i. EIA/TIA 455-60 - Measurement of Fiber Cable Length Using an OTDR.
j. EIA/TIA 455-61 - Measurement of Fiber Cable Attenuation Using an OTDR.
k. EIA/TIA 455-95 - Absolute Optical Power Test for Optical Fibers and Cables.

5. Title 24 - State of California Code of Regulations.
8. Occupational Safety and Health Administration (OSHA) Specifications.
9. IEEE Specifications:
   a. IEEE 802.2 Logical Link Control Working Group
   b. IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
10. NEMA VE1 Cable Tray Systems.
11. Underwriters Laboratories Specifications:
    a. UL 497 Electrical Grounding and Bonding Equipment.
    b. UL 1479 Fire Tests of Through-Penetration Fire stops.
13. ASTM Specifications:
    a. ASTM E 814 Methods of Fire Tests of Through-Penetration Fire Stops.
    b. ASTM E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

15. Americans With Disabilities Act (ADA).


17. Any existing campus specifications.

B. Where reference is made to a requirement that exceeds minimum code requirements, the specification requirement shall take precedence. The Contractor and the Owner's representative shall jointly resolve any work that is in apparent conflict with applicable codes.

C. When these specifications call for materials or construction of better quality or larger sizes than required by the above-mentioned rules and regulations, the provisions of these specifications shall take precedence.

D. In accordance with these laws, rules, and regulations, the Contractor shall provide the following:

1. Any additional material and labor that may be required for compliance with these laws, rules, and regulations, even though the work is not mentioned in these particular specifications.

2. All permits required by any of the legally constituted public authorities for the installation or construction of the work.

3. Any inspection or examinations required. Copies of certificates of all such inspections shall be delivered to the Owner's representative.

4. If any work is concealed without proper inspection and approval, the Contractor shall be responsible for all work required for opening and restoring the concealed areas, in addition to all required modifications.

1.05 General Requirements and Conditions

A. Safety

1. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of persons and property during performance of work.

2. The Contractor shall ensure that all personnel working in or anywhere on the site shall be provided a hard hat, safety shoes, a face shield or safety goggles, etc. for their protection.

3. If required by the campus, all personnel working in or anywhere on the site shall display a photo-ID.

4. The Contractor shall ensure that all personnel working in or anywhere on the site shall conform to the campus's regulations regarding confined space.

5. No act, service, drawing review, or construction observance by Owner's representative or any other party employed by the campus is intended to include review or approval of adequacy of the Contractor's safety measures, in, on, or near the construction site.

B. Quality Assurance

1. The specifications contained herein are set forth as the minimum acceptable requirements of the Contractor's Quality Assurance program. The Contractor is responsible for executing any other Quality Assurance measures necessary to ensure complete and fully functioning systems within the scope of this project.

2. The Contractor shall ensure that all design, workmanship, materials employed, required equipment, and the
3. The Contractor shall also ensure that each piece of equipment is in satisfactory working condition.

4. The Contractor shall certify that the cable manufacturers have carried out the quality assurance tests and procedures as specified herein. All cable shall be manufactured by an ISO 9001-Certified manufacturer.

5. The Contractor is responsible for ensuring that the cable packaging for shipping/storage purposes meets or exceeds the following requirements:
   a. One continuous length of cable per shipping reel/container.
   b. Reels shall be wooden or steel, sturdy, lagged, and shall have thermal protection jackets applied prior to lagging.
   c. Each reel/container shall be individually identified and marked with the length of the cable it contains. Said marking shall withstand weather and shipping conditions and remain readable.
   d. For fiber optic cable, results of the 100% Attenuation tests conducted at the factory shall accompany each reel.
   e. Cable shall be packed in a manner that facilitates the pre-installation tests to be conducted while the cable is still on the reel (i.e., both ends of the cable shall be accessible while protected from moisture).
   f. The Quality Assurance Plan employed shall include on-reel testing of fiber including, but not limited to, OTDR, power loss, attenuation, etc.

C. Manufacturer’s Literature: Where these specifications call for an installation to be made in accordance with the manufacturer’s recommendations, a copy of such recommendations shall always be kept on the job site and shall be available to the Owner’s representative.

D. Acceptance of Project

1. The University shall accept the project as complete based on the following criteria:
   a. Before executing any performance testing, the Contractor shall present a test plan in writing to the Owner’s representative for his or her written approval.
   b. The Contractor has completed all testing and delivered written copies of all test results to the Owner’s representative.
   c. All test results have been examined and approved in writing by the Contractor and University.
   d. Copies of all documentation required by this section have been delivered to the Owner’s representative.
   e. All punch list items are completed to the written satisfaction of the Owner’s representative.
2. Following completion and/or compliance with the requirements listed above, the Contractor shall issue a Notice of Completion confirming that the project is complete. A 45-day acceptance period shall begin immediately following the issuance of the Notice of Completion.

3. Minor failures shall be responded to at the University's discretion or within one business day.

E. Guarantee and Warranties

1. The installed structured wiring (as applicable for given cable media) system, including both inter- and intrabuilding sub-systems, shall be warranted for a 20-year period.

2. The Contractor shall be responsible for correcting any problems and malfunctions that are warranty-related for the entire warranty period.

3. Copies of any extended material warranties shall be passed through to the Owner's representative.

4. During the installation and up to the date of final acceptance, the Contractor shall protect all finished and unfinished work against damage and loss. In the event of such damage or loss, the Contractor shall replace or repair such work at no cost to the University.

F. Schedule

1. The Contractor shall submit, prior to project start, a time line for the project, showing all major dependencies and interactions with other trades. The schedule shall:
   a. Identify any and all disruption to existing services and/or service shutdowns on the schedule.
   b. Identify specifically the anticipated completion date for each building and each floor within each building. These completion dates shall be designated as milestones on the schedule.

2. The Contractor shall not take any facility out of service during the University's normal hours of operation without agreement from the campus. Any out-of-service activity shall be requested in writing and be coordinated two weeks in advance. The activity should generally be scheduled after hours.

3. The Contractor shall make updates to the time line and shall provide a weekly written status report to the Owner's representative.
   a. Each status report shall include details of project progress and shall describe any special incidents, activities, circumstances, or interruptions of workflow.
   b. The status reports shall specifically itemize areas that shall be affected by project activities planned for the succeeding week.
G. Certifications and Qualifications

1. The telecommunications contractor shall be trained and certified in installation of the chosen manufacture of the cabling components installed for a minimum of six months prior to the Close of Bid date for this project. The current certification shall also not be dated no later than one year prior to Close of Bid for this project.

1.06 Qualifications of Subcontractors

A. All subcontractors employed by the Contractor shall have a minimum of 5 years’ experience in satisfactory completion of jobs of similar scope and amount and be able to provide a 20 year applications warranty on the installed cable plant.

B. The Contractor shall compile detailed information relating to similar work completed by all subcontractors employed for this project, including corporate references, to enable the University to evaluate and agree to the subcontractors’ responsibility, experience, and capacity to perform the work.

C. Each subcontractor employed by the Contractor to perform telecommunications work on this project shall possess a C-7 (formerly C-61) Limited Specialty License for Telecommunications and shall be certified to install, terminate, splice, and test copper cables, fiber optic cable, riser cable, and inside wiring. This requirement ensures integration into, support, maintenance, and warrantee by the Contractor of the University’s existing telecommunications infrastructure. The appropriate subcontractor’s license for underground construction and conduit installation is also required.

D. An on-site Contractor superintendent shall be available at all times. Contact can be by person, telephone, or pager.

1.07 Product Requirements

A. General Information

1. These specifications identify the minimum specifications for product quality acceptable on this project by designating a manufacturer’s trade or brand name and catalog or model number or by describing attributes, performance, or other specifications.

2. Where applicable, the most recent manufactured product line consistent with the structured cable system supplier identified in the technical specification sections is to be the minimum standard for quality and performance of products to be used on this project.

3. For any product described only by attributes, performance, or specifications, the Contractor shall develop a written Product Submittal in accordance with the requirements set forth herein. All Product Submittals shall be reviewed and approved in writing by the Owner’s representative prior to their use and installation on the project.

4. Such phrases as “or equal,” “or equivalent,” and “or acceptable substitute” indicate that an equivalent product may be proposed as a substitute for that which is specified. The proposed substitution shall meet or exceed the attributes, performance, or other specifications of the specified product and shall be approved by the Owner’s representative.

5. Failure of the Contractor to submit proposed substitutions for written approval in the manner described above shall be sufficient cause for disapproval by the Owner’s representative of any substitutions otherwise proposed.

6. Physical samples may be required. If tests to determine equality and utility are required by the Owner’s representative, they shall be made by a testing laboratory with the acceptance of the test procedure first given by the Owner’s representative, at the expense of the Contractor.

B. Quality of Materials

1. All materials and equipment supplied by the Contractor shall be new, manufactured within one (1) year prior to installation, and meet or exceed the latest published specifications of the manufacturer. All material shall be acceptable to and approved by the University as meeting these specifications. All non-consumable
products shall have a 20-year quality guarantee.

2. All communications materials used on this project shall conform, where applicable, to the following specifications, unless otherwise noted:
   a. NEMA - National Electrical Manufacturers Association.
   b. ANSI - American National Specifications Institute.
   c. UL - Underwriters Laboratories, Inc.
   d. The latest IEEE and EIA/TIA 568 specifications.
   e. FCC and NCTA Coaxial Cable Television Specifications.

3. Telephone system materials and equipment shall be FCC Type-accepted and certified as such by supplier.

4. No material employed shall present environmental or toxicological hazards as defined by current industry specifications. All materials shall comply with CAL OSHA and EPA specifications or applicable federal or state laws or regulations.

5. The equipment, apparatus, and material for fiber optic equipment and apparatus shall conform to existing CAL OSHA health and safety laws. The equipment and apparatus shall have provision for application of safety labels, such as LASER identification, or warning labels as required by system considerations.

C. Materials Delivery and Storage

1. Costs of all shipping to the site, inside handling, and all unusual storage requirements shall be borne by the Contractor.

2. The Contractor shall make appropriate arrangements and coordinate with authorized personnel at the site for the proper acceptance, handling, protection, and storage of materials so delivered.

3. All materials delivered to the site shall be received, handled and stored by employees of the contractor.

1.08 Structured Cabling System

A. Proposed Structured Cabling Solution

(1)
1. Bidders shall submit the name and a complete description of the proposed structured cabling system, features and functions, and warranty coverage with their bids. They shall include manufacturer's documentation demonstrating that all specified features, operating specifications, quality of service, and warranty conditions listed in the drawings and specifications are met or exceeded.

2. The Connectivity Solution installed for this project shall have:

3. Workstation outlets shall be:

4. Ortronics 6 port faceplate OR-4030054-xx (color to be determined on drawings)

5. Ortronics TracJack OR-63730003

6. Electrical Ivory for voice

7. Orange for data 1

8. Green for data 2

9. Ortronics TracJack OR-63700006-xx (color to match faceplate) where required on contract drawings

10. Ortronics TracJack OR-63700039-xx (color to match faceplate) where required on contract drawings

11. Voice Termination Panels shall be Systimax VisiPatch as specified in Section 16720

12. Data Termination Panels shall be as specified in Section 16720

13. A full line of TIA/EIA 606-A compliant faceplates and patch panels that clearly designate an information outlet (IOT) labeling area and a clearly designate work area (WA) labeling area.

14. A full line of standard punch-down as well as custom configurable modular patch panels, including standard flush mount, angled and recessed.

15. Meet the compatibility requirements set forth in the Cisco Verification of Interoperability Program

16. Provide warranty in either Permanent Link or Channel configuration for coverage to repair and replace defective components.

17. Provide and end-to-end copper cabling system warranty as well as provide open architecture warranty with alternative UTP cable manufacture.

B. Structured Cabling System Submittal

1. The University will consider manufacturer's structured cable systems, provided the bidder submits the required documentation on the proposed cabling system. The documentation shall include a complete written description of the proposed structured cabling system, including name of connectivity and cable manufacture, demonstrate where the selected products meet or exceed the specifications set forth in this document, and the manufacturer’s service organization to support a minimum twenty (20) year warranty.

2. The University shall receive the System submittal documentation from the bidder within fourteen (14) working days prior to the close of bid.

3. The justification for the System shall demonstrate item by item that all structured cabling system requirements shown on the drawings and listed in the specifications are met or exceeded.

4. The University reserves the right of making final decisions on all proposed “or equal” substitutions.
A. Structured Cabling System Pre-Qualification Certificate: The Communications Contractor shall submit a letter of approval from the selected manufacturer indicating completion of pre-qualification requirements for installation of the selected Structured Cabling System. Documentation shall include training certificates for installation of the proposed products.

B. Shop Drawings and Supplemental Data

1. Copies of shop drawings and supplemental data shall be provided for the University’s review. Shop drawings shall be submitted for all communications equipment, cabling, and structure pertaining to the job (distribution frames, conduit, wire, fiber optic cable, terminations, splices, etc.)

2. Design submittals (reflecting field conditions, actual cable lengths, equipment elevations, and performance expectations) shall be prepared for each system included in the project scope and reviewed with the Owner’s representative.

3. Copies of final shop drawings and supplemental data, where called for, shall be submitted to the Owner’s representative. Final corrected copies of schedules and shop drawings or supplemental data shall be as follows (exceptions shall be noted in Specification Sections):
   a. One (1) for the University Chief Information Office files.
   b. One (1) for the University's Information Technology Engineering Group.
   c. One (1) to the Contractor’s job files, and such additional copies as the Contractor may desire for its own office files and/or for distribution to subcontractors or vendors.

4. The shop drawings and supplemental data called for shall be submitted as the instruments of the Contractor, even though they may have been prepared by a subcontractor, supplier, dealer, manufacturer, or by any other person, firm, or organization. Prior to submission, the Contractor shall undertake its own review and stamp with its acceptance, then submit to the Owner’s representative for his or her review. By accepting and submitting shop drawings and supplemental data, the Contractor represents that it has determined and verified all field measurements, the physical construction, the quality of materials, the applicability of catalog numbers, and similar data, or will do so, and that it has checked and coordinated each shop drawing with the requirements of the field conditions. Conflicts between trades shall be resolved by the Contractor in the shop drawings, if possible, but in any event prior to the actual construction.

5. All shop drawings shall be drawn accurately on paper suitable for duplicate copying by black, blue line printing processes or photocopy.

6. Supplemental data shall include information as noted in the specification paragraphs requiring them.

7. The Owner’s representative will review shop drawings and supplemental data submitted by the Contractor only for general design conformance with the concept of the project and compliance with the information given in the Contract Documents. A review status of “No Exceptions Taken” on a submittal does not relieve the contractor of the requirements to comply with building codes or the contract specifications.”

8. Shop drawings, if requested, shall be submitted in writing to and approved by the Owner’s representative before being used by the Contractor on the job.

9. Shop drawings delineation: The shop drawings shall be drawn to scale and shall be completely dimensioned, giving the plan together with such sections as are necessary to clearly show construction detail.

10. Responsibility
   a. The shop drawings and all supporting data, catalogs, etc. shall be prepared by the Contractor or its suppliers. Therefore, the Contractor shall check the drawings of its suppliers as well as its own drawings before submission.
   b. In particular, the Contractor shall ascertain that the submittal drawings meet all requirements of the contract drawings and specifications and also conform to the structural and space conditions.
c. Each shop drawing submitted for University approval shall bear a stamp certifying that it has been checked by the Contractor in accordance with the specifications. If such shop drawings show variations from Contract Documents, whether because of standard shop practice or other reasons, the Contractor shall make special mention thereof in the transmittal letter.

d. The Contractor shall be fully responsible for observing the need for and making any changes in the arrangement of piping, connections, wiring, manor of installation etc. that may be required by the proposed equipment, both as pertains to its own work and any work affected under other parts, headings, or divisions of Drawings and Specifications.

11. Identification: Shop drawings shall be titled with the name of the project on each sheet and shall otherwise be identified by listing the particular division, section, article or reference of the work to which they pertain. Different items shall be submitted on separate sheets, and all submittals shall be numbered serially.

12. Manner: The Contractor shall furnish separate submittal sheets for each specialty item for Owner's representative written approval in the following manner:

   a. Five (5) copies of catalog cut sheets shall be submitted. The cut sheets shall be photocopied or reproduced in some other acceptable manner on one side only of an 8 1/2" x 11" sheet, noting only the items in question, together with the descriptive (specification) data.

   b. Each sheet shall be identified with the division, section, article or reference in the Contract Documents that covers the item submitted for approval.

   c. Each sheet shall be identified with the project name.

   d. Each sheet shall bear the Contractor's stamp and signature of approval.
1.10 Record Drawings

A. The Contractor shall keep one set of drawings on site to continually maintain an accurate record of the as-constructed work.

B. The marked-up drawings shall accurately indicate location of equipment, pull-boxes, conduits, cable types and labeling.

C. Within thirty (30) days of completing work, the Contractor shall submit five (5) copies of as-built drawings to the Owner's representative. In addition, the Contractor shall provide an electronic copy of the as-built drawings in a format specified by the Owner's representative.

1.11 Definitions

A. Backboard: Backboard generally refers to A-C, fire-retardant, plywood sheeting lining the walls of the telecommunications facilities. Backboards may also refer to the entire wall-mounted assembly, including wire management and termination frames.

B. Building Distribution Frame (BDF): The BDF is the location within a building where the entire inside cable and fiber optic plant originates. The entire cable and fiber optic entrance facilities also terminate here. Part of the Horizontal Distribution System may originate here as well. It may include: the physical location, enclosure, wire and copper cable management hardware, fiber and management hardware, termination hardware, distribution hardware, protection hardware, active electronic components, and equipment racks. EIA/TIA-569 “Commercial Building Standard for Telecommunications Pathways and Spaces” refers to the room housing the BDF as the Equipment Room. Throughout this specification, BDF and Telecommunications Equipment Room are equivalent.

C. CATV: Cable Antenna Television system.

D. Cable Plant: Cable, conduit raceways, vaults, junction/pull boxes, rooms, racks, equipment, patch bays/blocks, and other infrastructure required to provide physical, electrical, optical connectivity between buildings on the Campus.

E. Cable Runway: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wiring inside the MDF, BDF, or IDF rooms. Also called Ladder Rack.

F. Cable Tray: Hardware designed and manufactured for horizontal pathway distribution of cable and inside wire from the MDF, BDF, or IDF to the Information Outlet access point.

G. Copper Entrance Cable: Copper Cable that joins the University's backbone infrastructure at its connecting point to the buildings BDF.

H. Designation Strips: Paper or plastic strips, usually contained in a clear or color tinted plastic carrier, designated for insertion into a termination frame. Designation strips are usually imprinted with the adjacent terminal number and are used to aid in locating a specific pair, group of pairs, or information outlet inserted into the termination frame, or for the purpose of delineating a termination field.

I. Entrance Conduit: Conduit that connects the University's underground infrastructure with the building's BDF.

J. Fiber Entrance Cable: Fiber optic cable that joins the University's backbone infrastructure at its connecting point to the buildings BDF.

K. Horizontal Cable: Copper, coaxial, or fiber optic cable that connects the information outlets to the BDF or IDF. See also ‘Station Wire’.

L. Information Outlet (IOT): An integral assembly containing a variety of jacks and/or connectors that can be used for various services (voice, data, video, network, etc.).

1. The wall jacks are mounted in single gang faceplate attached with a single-gang reducer ring mounted in dual gang standard electrical outlet box. A mounting frame and blank dust cover(s) are provided for the
unused position. The assembly includes the faceplate, modular mounting frame, jacks, and dust cover/blank.

M. Inside Plant (ISP): Communications system inside a building (wire, fiber, coaxial cable, equipment and racks, information outlets, etc.).

N. Intermediate Distribution Frame (IDF): The IDF is the location in a building where a transition between the Riser System and the Horizontal Distribution System occurs. It may include: the physical location, enclosure, wire and cable management hardware, fiber and management hardware, active electronic components, termination hardware, and equipment racks. EIA/TIA-569, “Commercial Building Specifications for Telecommunications Pathways and Spaces” refers to the IDF as the Telecommunications Closet. Throughout this specification IDF and Telecommunications Room are equivalent.

O. LAN: Local Area Network.

P. Main Distribution Frame (MDF): The MDF is the location, within a building, where the entire outside cable and fiber optic plant originates. It may include the physical location, enclosure, wire, fiber, and copper cable hardware, protection, active electronic components, equipment frames and racks. EIA/TIA – 569 “Commercial Building Standard for Telecommunications Pathways and Spaces”: refers to the room housing the MDF as the Equipment Room. This space could be the Telecommunications Switching Center and/or the Computer Center and may vary by campus. For CSUMB, Building 41A is the primary MDF, with Building 11 being an auxiliary MDF.

Q. MPOE: Minimum Point of Entry, Utility Partnerships/Alternate Carrier, located within the MDF.

R. Management Hardware

1. Fiber Management: Hardware designed and manufactured for the purpose of keeping fiber patch cords neat and orderly. Most termination frame manufacturers provide fiber management components designed to work in conjunction with their termination frames. Fiber management may also refer to other types of hardware for the purpose of securing fiber optic cable to the building.

2. Wire Management (Copper, Data, Network): Hardware designed and manufactured for the purpose of keeping cross-connect wire and patch cables neat and orderly. Most termination frame manufacturers provide wire management components designed to work in conjunction with their termination frames. Wire management may also refer to other types of hardware for the purpose of securing wire and cable to the building.

S. Outside Plant (OSP): Communications system outside of the buildings (typically underground conduit and vaults, exterior/underground rated wire and cable, etc.).

T. Riser Cable: High volume cable (copper) that connects the BDF with the IDF or backboards located on the same or different floors.

U. Riser Conduit: Conduit that connects the BDF to the IDF or backboards located on the same or different floors.

V. Riser Fiber Cable: Fiber Optic Cables that connects the BDF with IDF or backboards located on the same or different floors.

W. SPOE: Secondary Point of Entry, Utility/Alternate Carrier Partnership in buildings other than the MDF.

X. Station Wire: Copper, coaxial, or fiber optic cable that connects the information outlet to the BDF or IDF. See also ‘Horizontal Cable.’

Y. Telecommunications Ground: An electrical ground (as defined by local codes), usually the main building ground electrode extended by a continuous AWG "0" wire to ground bus bars in the BDF, IDF, and roof telecommunications terminal point.

AA. Telecommunications Space (TS): Any area, other than the workstation, where telecommunications equipment is located. May include terminated cable and patch panels, racks, cabinets and network electronics. Each TS shall be identified as specified in Exhibit 16720-B “Label Grammar”.

BB. Termination Fields:

1. Copper, Data, Network Termination Fields: A group of termination frames clustered together to provide terminations for specific cable or inside wiring groups, where all of the cable or wiring in the group is used for a single purpose, constitutes a copper, data, or network termination field. The extent of a specific field, located in a group of fields, may be distinguished by a physical separation between the frames forming the field, by uniquely colored designation strips, or by a series of terminal numbers.

2. Fiber Optic Termination Fields: A group of termination frames clustered together to provide terminations for fiber optic cable fibers, where all of the cable fibers are used for a single purpose, constitutes a fiber termination field.

CC. Termination Frames:

1. Copper Termination Frame: Device designed and manufactured for the purpose of terminating large numbers of copper cable or station wire pairs. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Copper Termination Frame and Wiring Block are equivalent.

2. Data Termination Frame: Device designed and manufactured for the purpose of terminating copper cable pairs from the active data electronic hardware. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Data Termination Frame and/or Data Patch Panel are equivalent.

3. Fiber Termination Frame: Device designed and manufactured for the purpose of terminating fiber optic cable fibers into “SC” connector field. Throughout this specification the terms Fiber Termination Frame and Fiber Patch Panel are equivalent.

4. Network Termination Frame: Device designed and manufactured for the purpose of terminating copper cable pairs from the active data electronic hardware. These devices generally utilize insulation displacement connections and usually require special tools to make the terminations. Throughout this specification, the terms Network Termination Frame and Network Jack Panel are equivalent.

PART 2 – MATERIALS

2.01 Not used

PART 3 – EXECUTION

3.01 Not used

END OF SECTION
SECTION 16715
TELECOMMUNICATIONS ACCEPTANCE TESTING

PART 1 – GENERAL

1.01 Section Includes:

A. Publications and Standards.

B. Inspection and testing procedures for copper and fiber optic cable systems.

C. Documentation.

1.02 Publications and Standards

A. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

1. EIA/TIA 568-B.1, B.2, B.3 - Commercial Building Telecommunications Wiring Standard.

2. EIA/TIA 569A - Commercial Building Standard for Telecommunications Pathways and Spaces

3. EIA/TIA TSB 140 – Two Tier Fiber Optic Testing.

4. EIA/TIA 606A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings


6. EIA - 310-D - Cabinets, Racks, Panels, and Associated Equipment

7. EIA/TIA-455-57A - Optical Fiber End Preparation and Examination

8. EIA/TIA 455-59 - Measurement of Fiber Point Defects Using An OTDR

9. EIA/TIA 455-60 - Measurement of Fiber or Cable Length Using An OTDR

10. EIA/TIA 455-61 - Measurement of Fiber or Cable Attenuation Using An OTDR

11. EIA/TIA 455-95 - Absolute Optical Power Test for Optical Fibers and Cables

12. EIA/TIA 526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant


B. Federal Communications Commission (FCC), Part 15 and Part 68

C. Rural Electrification Association (REA), Bulletin 345-63, REA Standards for Acceptance Tests and Measurements of Telephone Plant


1.03 Related Sections
A. Contract Terms and Conditions

B. Section 16710 - Telecommunications General Requirements

C. Section 16720 - Telecommunications Basic Materials and Methods

D. Section 16725 - Telecommunications Cable

E. Section 16730 - Underground Structures – Telecommunications

F. Section 16740 – Building RF (CATV) System

G. Section 16760 - Telecommunications Grounding and Bonding

PART 2 – PRODUCTS

2.01 Not Used

PART 3 – EXECUTION

3.01 General Procedures

A. The Contractor will provide all tools, equipment, and fully trained staff necessary to conduct fully witnessed acceptance testing of all installed telecommunications-related products and systems.

B. The Contractor shall prepare a complete test plan for all installed telecommunications systems for review and approval by the Owner's representative. The plan shall show, at a minimum, test configuration, calibration procedures, testing schedule and testing equipment to be used. The scope of this work includes, but is not limited to, the following:

1. All system(s) shall be checked for compliance with these specifications.

2. The Contractor shall maintain a check-off list for University reference during tests.

3. The result of the measurements outlined shall be recorded and submitted along with current as-built drawings to the Owner's representative as final proof of system performance.

4. The Contractor shall expeditiously replace any system not meeting specifications at any cost to the University. Failure to act in an expeditious manner to properly remedy any abnormality resulting from installation/construction defects or workmanship; faulty material; and/or the failure of the systems, components, or the cable medium to perform in accordance with the University and/or Manufacturer's technical specifications shall cause the University to place a “hold” on any other telecommunications development or construction associated with this project. The Owner's representative will notify the Contractor in writing of such action and is absolved and shall be held harmless from any delays, costs over-runs, scheduling difficulties, etc. assessed by others due to the Contractor’s failure to meet the final proof of system performance specifications. Final as-builts will be provided, as specified, at the end of the project.

5. All systems shall meet the bid specifications and be accepted by the Owner’s representative before the work will be considered complete.

C. After the Contractor has provided complete documentation of all testing and the documentation has been reviewed by the Owner's representative, the Contractor shall conduct “proof of performance” testing on selected components at the direction and discretion of the Owner’s representative. Such testing will utilize the same equipment and procedures used to conduct and document the initial tests but will be applied on a random basis to
verify the testing documentation. If in the judgment of the Owner's representative, the proof-of-performance test results vary significantly from the acceptance test results, the Contractor shall continue with testing until cleared by the Owner's representative.

D. A certified laboratory or the manufacturer shall calibrate all test equipment within the last six months, and such certification shall be submitted to the Owner's representative prior to testing.

E. All testing shall be coordinated with the Owner's representative (providing a minimum of 48 hours notice) to ensure all acceptances and qualified personnel can witness proof-of-performance testing.

3.02 Inspection and Testing Procedures for Copper Cable

A. The Owner's representative will conduct routine inspections of the work in progress, and any deficiencies will be discussed at the regular progress meeting. In the event the Owner's representative determines work is progressing in an incorrect manner and waiting for the regular meeting could cause further problems, the Contractor's on-site project manager will be notified.

B. Copper Station and Riser Cables: The Contractor shall conduct witnessed acceptance testing on all station and riser cable installed as part of this project as defined below:

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category 6 performance. Horizontal cabling shall be tested using a level III or higher test unit for Category 6 performance compliance.

2. The correct and continuous bonding of cable shields through all riser and tie cable splices will be verified. This test shall be conducted from the BDF prior to strapping shield grounds at splice or termination points.

3. Each station cable and all riser cable pairs will be tested for crosses, opens, grounds, reversed and/or transposed pairs, shorts, foreign battery, continuity, and resistance (in ohms). All riser cable pairs shall be tested for loss in dB. All problems will be resolved and the cable re-tested to ensure compliance.

4. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-A including TSB40A and TSB67 and amendments. The appropriate level III tester shall be used to verify Category 6 cabling systems. The field test equipment shall be approved by the Structured Cabling System manufacture. All stations shall meet or exceed this performance standard.

5. All test results, including jack numbers, shall be printed on a hardcopy report. All the station test results will be provided in electronic format (CD or floppy disk), and a copy of any software required to read and/or print the results is also provided at the same time.

C. Copper Interbuilding and Entrance Cables: The Contractor's witnessed acceptance testing on all interbuilding and entrance cables installed as part of this project is defined below:

1. The correct and continuous bonding of cable shields through all interbuilding splices shall be verified. This test shall be conducted from the MDF and BDF prior to strapping shield grounds at splice or termination points.

2. Each cable pair shall be tested for crosses, opens, grounds, reversed and/or transposed pairs, splits/re-splits, shorts, foreign battery, continuity, resistance (in ohms) and loss in dB.

3. All irregularities will be resolved and the cable re-tested to ensure compliance.

4. Interbuilding Cable test results will also be provided in electronic format on compact disc.

3.03 Inspection and Testing Procedures Fiber Cable
3.04 All fiber optic cable testing will utilize the TIA/EIA TSB-140 Tier II testing Method

A. Fiber Optic Riser And Station Cable

1. The appropriate high resolution OTDR device shall be used to test the fiber riser cable. Tracing printouts (noting the appropriate optical fiber and buffer tube color designation) shall be mounted on separate pages and bound into a three-ring notebook. An incremental scale that reflects the short lengths of cable involved in these tests shall be utilized.

2. All fiber riser cable shall be OTDR tested from the building's BDF to each fiber IDF terminal and from the IDF to the BDF at the 850nanometer wavelength. The results of OTDR testing to define the length of each riser cable shall be documented.

3. The Contractor shall conduct a power meter (loss) test of each fiber optic station and riser cable at both 850 and 1320 wavelengths A to B, B to A, and OSPL (OSPL is defined as La + Lb). Individual station or riser fiber link segment shall measure no more than 0.5 dB per connector plus the calculated fiber loss for the measured length of the segment. Tests shall be conducted using ANSI/EIA/TIA-526-14A, Method B.

4. The Contractor shall provide a hardcopy printout list reflecting cable ID and actual measured loss. The station test results shall also be provided in electronic format (floppy disk or CD-ROM), as long as a copy of any software required to read and/or print the results is also provided at the same time.

B. Fiber Optic Interbuilding and Entrance Cable

1. The appropriate high resolution OTDR device to test the fiber interbuilding and entrance cables shall be used. Tracing printouts (noting the appropriate optical fiber and buffer tube color designation) shall be mounted on separate pages and bound into a three-ring notebook. An incremental scale that reflects the short lengths of cable involved in these tests shall be utilized.

2. All fiber interbuilding cable shall be OTDR tested from the MDF to the building's BDF terminal. Each fiber strand will be tested from both ends and at both wavelengths. The results of OTDR testing to define the length of each riser cable shall be documented.

3. The Contractor shall conduct a power meter (loss) test of each fiber optic interbuilding cable at both wavelengths A to B, B to A, and OSPL (OSPL is defined as La + Lb). Individual interbuilding fiber link segment shall measure no more than 0.5 dB per connector plus the calculated fiber loss for the measured length of the segment. The tests shall be conducted using ANSI/EIA/TIA-526-14A, Method B.

4. A hardcopy printout list reflecting cable ID and actual measured loss shall be submitted to the Owner's representative. The station test results shall also be provided in electronic format (floppy disk), as long as a copy of any software required to read and/or print the results are also provided at the same time.

3.05 Inspection and Testing Procedures Coaxial Cable

A. Contractor shall test all such cable with a TDR designed for coaxial cable usage. Test shall be capable of detecting continuity, shorts, and undesired discontinuities to a return loss of 30 dB. Finished length shall also be determined via TDR.

B. Complete System Installation

1. The Contractor shall perform and document all tests and measurements recommended and/or required by the manufacturer of the individual products installed in the distribution system.

2. The Contractor shall perform and document all tests and measurements recommended by the Federal Communications Commission, the Society of Cable Telecommunications Engineers and
3. The Contractor shall provide the University with the results of the proof of performance tests normally associated with Cable Antenna Television distribution systems as a part of the final acceptance procedures. A qualified University representative shall witness all final testing and acceptance procedures.

C. The CSU Monterey Bay project staff shall conduct routine inspections of the CATV System installation process and any deficiencies shall be discussed at the regular progress meeting. In the event that the campus project staff determines that the CATV System work is progressing in an incorrect manner and waiting for the regular meeting could cause further problems, the Contractor's on-site project manager shall be immediately notified.

D. After aligning and balancing the CATV System, the Contractor shall conduct witnessed acceptance and leakage tests on the CATV System, including the coaxial cables, active, and passive devices. The Owner's representative shall witness all CATV System acceptance and leakage test procedures.

E. Details of the methods to be followed in conducting the acceptance and leakage testing shall be found in the National Cable Television Association (NCTA) Recommended Practices for Measurements on Cable Television Systems, 2nd Edition, November 1989.

F. The Contractor shall provide CATV System test equipment that has been calibrated by a certified laboratory or by the manufacturer within the last six (6) months, and such certification shall be submitted to the Owner's representative prior to any CATV System testing.

G. The Contractor shall provide all test, measurement, and leakage equipment required for the CATV System acceptance and leakage testing procedures. The test, measurement, and leakage equipment shall include but is not limited to:

1. CATV Broadband Sweep Transmitter and Receiver.
2. NTSC Video Pattern Generator.
3. CATV Network Analyzer, capable of spectrum analysis, signal level measurements, carrier to noise measurements, distortion measurements, and hum modulation measurements.
4. CATV Signal Level Meter.
5. Calibrated Attenuator.
6. Tunable Band pass Filter / Preselector.
7. Pre-amplifier.
8. Broadband amplifier.
10. Cable Leakage Meter and Antenna.

H. The Contractor shall ensure that the CATV System meets or exceeds the following system design criteria at any and all CATV System drops:

1. Minimum signal level: +6 dBmV.
2. Maximum signal level: +15 dBmV.
3. Maximum difference between adjacent video carriers: 1 dB.
4. Maximum difference between any video carriers: 7 dB.

5. Carrier to noise ratio: 43 dB (minimum).

6. Hum: 1%.

I. A broadband sweep signal, from a CATV sweep transmitter ranging from 50 to 860 MHz., or an equivalent approved by the Owner's representative, shall be inserted at the input to the optical transmitters located in the University's CATV headend. In addition, where available, a broadband RF input from the campus CATV system shall be simultaneously applied to the transmitter input.

J. A CATV sweep receiver shall be used to measure frequency response, peak to valley differences, and level at the node or fiber receiver output and at input and output of all CATV System Amplifiers.

K. Where a return system is installed as part of the construction, sweep tests shall also be performed on this system.

L. A CATV Network Analyzer shall be used to measure visual Carrier to Noise Ratio (CNR), Composite Second Order (CSO), Composite Triple Beat (CTB), modulation distortion at power frequencies (HUM), and cross modulation (XMOD) at the input and output of all CATV System Amplifiers.

M. Where the system is cable powered, the voltage at each power supply and amplifier shall be measured with a TRMS multi-meter and recorded as part of the test documentation.

N. All amplifiers shall have the both the DC operating voltage and AC ripple measured with a multi-meter and recorded as part of the test documentation.

O. The Contractor shall conduct witnessed signal leakage measurements in conformance with FCC 76.605(a) (14) and 76.609(h). A cable leakage meter and antenna shall be used to detect any undesired radiation of electromagnetic energy from the CATV System. Any signal leakage in excess of that allowed by the FCC shall be identified and corrected.

P. The Contractor shall test each CATV System outlet and shall add attenuators and/or in line equalizers, or otherwise balance the system so that each outlet provides the signal levels and quality defined in item # H above.

Q. The signal at each CATV System outlet shall be free of additional noise and distortion as judged by the Owner's representative. The Contractor shall determine, using a CATV network analyzer, that the signal at each outlet conforms to the signal levels and quality defined in item # H above. If excessive noise and/or distortion products are present, the Contractor shall resolve the problem(s) and retest.

R. The Contractor shall provide both an electronic record (disc) and a printed copy of the results of the CATV System tests and measurements identified above to the Owner's representative.

3.06 Documentation

A. Fiber Cable Systems

1. All documentation shall be neatly and legibly done and shall provide a clear understanding of the installed system.

2. The Contractor shall prepare “as-built” plans of cable routes, cable lengths, and information outlet locations (both new and existing), including interbuilding, entrance, and riser cable locations with footage. All approved changes and actual in-place footage shall be marked, in red, on a “D” size drawing. The as-builts shall include all fiber optic cable placed with cable lengths, fiber assignments, and cable numbers and counts. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. Drawings shall be provided in AutoCAD format on CD-ROM.
3. The Contractor shall provide signed originals of all acceptance testing documents, which are:
   a. Fiber optic insertion loss results (using forms provided by the University)
   b. OTDR traces and results on floppy disc or CD, and provided with any software required to view the results.
   c. Current test equipment certifications

B. Copper Cable Systems

1. Documentation shall be submitted within ten (10) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.

2. Station cable test results noting unique jack (JCK) identifier as well as the information outlet (IOT) number shall be provided.

3. Interbuilding and Riser copper test documentation will include the following:
   a. Pass/Fail status of crosses opens grounds, reversed or transposed pairs, splits/re-splits, shorts, foreign battery, continuity, and resistance.
   b. The length of the tested pairs in feet.
   c. Number of splices in the tested length.
   d. Proper cable identification, including pair counts.
4. Test Results documentation shall be provided on disk within one (1) week prior to Beneficiary Occupancy of the Building. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation”, the project name, and the date of completion (month and year).

5. The Contractor shall prepare “as-built” plans of cable routes, cable lengths, and information outlet locations (both new and existing). All approved changes and actual in-place footage shall be marked, in red, on a “D” size drawing. The as-buils shall include copper cable placed with cable lengths, cable numbers and counts. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. Drawings shall be provided in AutoCAD format on CD-ROM.

6. Interbuilding, entrance, and riser plans shall be updated to include actual routes, cable numbers and counts, and lengths of cables.

7. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

8. The Owner’s representative may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Owner’s representative, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

C. CATV System

1. The Contractor shall provide signed originals of all CATV System test equipment certificates of calibration to the Owner’s representative.

2. The Contractor shall provide an electronic record (disc) of all CATV System inspection, testing, and measurements to the Owner’s representative, including:

3. Legible depictions of the signal levels and the technical quality measurements at the input ports of the optical transmitters.

4. Legible depictions of the signal levels and the technical quality measurements at the output ports of the optical transmitters.

5. Legible depictions of the signal levels and the technical quality measurements at the input ports of the amplifiers.

6. Legible depictions of the signal levels and the technical quality measurements at the output ports of the amplifiers.

7. Legible depictions of the signal levels and the technical quality measurements for each Contractor provided CATV System outlet.

8. A typed list of the CATV System signal leakage measurements.

END OF SECTION
SECTION 16720

TELECOMMUNICATIONS BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.01 Section Includes:

A. Hangers and Cable Ties
B. Cable Runway
C. Fire Stopped Sleeves
D. Inner duct – Outside Plant
E. Equipment Racks
F. Enclosed Cabinets
G. Extra Large Building Entrance Frame (XLBET)
H. Protector Panels
I. Wall Mounted Wireless Access Point Enclosures
J. Non-metallic and metal surface raceways.
K. Cable Racking and Rack Hooks (OSP)
L. Splice Cases – Outdoor/ Indoor Copper/Fiber
M. Fiber Optic Terminal Panels
N. Fiber Optic Couplers
O. Fiber Optic Connectors
P. Cable Tags and Splice Case Labels
Q. Outlet Labels
R. Splicing Bay and Relay Rack Labels
S. Jack Modules/Connectors
T. Faceplates
U. Copper Cable Termination Blocks
V. Data Network Patch Panels
W. Wire Management
1.02  Related Sections

A. Contract Terms and Conditions
B. Section 07840 – Fire Safing/Fire Stopping
C. Section 07270 – Fire Stopping
D. Section 16710 - Telecommunications General Requirements
E. Section 16715 - Telecommunications Acceptance Testing
F. Section 16725 - Telecommunications Cable
G. Section 16730 - Underground Structures – Telecommunications
H. Section 16740 - Campus CATV System
I. Section 16760 - Telecommunications Grounding and Bonding

1.03  Applicable Publications

A. As defined in Section 16710 - Telecommunications General Requirements.

1.04  Submittals

A. The Owner’s representative shall receive the following Contractor submittals prior to the start of work:
B. Product data for:
   1. Wire hangers and Cable ties. (Non-plenum/plenum)
   2. Non-metallic and metal surface raceways
   3. Cable Runway
   4. Inner duct
   5. Cable racking and rack hooks (OSP)
   6. Splice cases (Outdoor/Indoor copper and fiber)
   7. Fire Stopped Sleeves
   8. Fiber optic termination panels (FTU’s)
   9. Cable tags and labels.
   10. Communications backboards.
   11. Station outlets. (Faceplates, voice and data jacks; metallic and non metallic outlet boxes)
   12. Copper cable termination blocks (110 type termination blocks)
   13. Equipment racks.
15. Wire managers.
17. Protector panels and protector units.
18. Communication poles.
19. Enclosed cabinets. (Floor mounted and wall mounted)
20. XLBET frames

PART 2 – MATERIALS
A. The Contractor shall install materials and equipment as part of the selected Structured Cabling System. The various sections of this specification pertain to specific products and/or installation requirements that shall conform to the warranty requirements of the selected Structured Cabling System. See specification section 16710-1.8 Structured Cabling System.

2.02 Hangers and Cable Ties

A. Materials: All hangers and cable ties shall be designed to support communications cable (including the fiber) without kinking or damage. Horizontal cable supporting hardware shall be UL Listed. The J-hook(s) shall provide a broad base for proper cable support, thereby reducing stress and bending of cabling. Contractor shall utilize the sufficient number of J-hooks per Manufacturer’s recommended cable capacities for the number of cables to be installed, plus the greater of 20% spare j-hooks or one spare j-hook per location.

1. Hangers shall be metal construction and shall provide a cable support hanger in a “J” configuration designed to support multiple communications cables.
2. No more than twelve (12) station cables may be supported by a single hanger without using a saddle (3 inches wide at a minimum) to support the weight of the additional cables.
3. Larger types of wire hangers (larger J-hooks or Tri-hooks) are acceptable for locations requiring more than twelve cables. Copper and fiber cables shall be properly installed per the manufacturer’s specifications to insure maximum cable performance.
4. Cable ties used within a rated ceiling plenum space shall be rated low smoke and shall be certified for use in a plenum environment. (UL Listed) NEC section 300-20. Cable ties within the Telecom Space shall be of the fabric loop and hook type. All cable ties used above the ceiling shall be plenum rated.
5. When nylon cable ties are used, they shall be installed so that the cable jacket is not deformed.

B. Manufacturers: 3-M, Panduit, Erico/Caddy or approved equivalent.

2.03 Cable Runway

A. Materials

1. Cable support runway shall be installed as defined in the Contract Documents and in any location where additional pathways are required to support large numbers of station cables that are otherwise not supported.
2. The runways shall be twelve inches wide unless otherwise noted.
3. In some locations the cable runway shall be equipped with a four-to-six inch fence on both sides to support bundles of patch or jumper cables. This fence shall mechanically attach to the side or bottom of the runway, not the surface over which the cable will be placed.
4. In some locations, as indicated by the drawings, the cable runway shall be equipped with ‘waterfalls’, or other manufacturer recommended bend radii control devices.
5. The cable runway shall be classified by Underwriters Laboratories (UL) as suitable for equipment grounding.
6. The cable runway shall be earthquake braced; seismic zone 4.
7. The Contractor shall provide manufacturer’s standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps as necessary to install a complete system.
8. BDFs and IDF's shall have 1 ½ inch steel tubular stringer style cable runway, finished in Black (UL Classified). Rated at 95 lbs./ft supported at 5 ft intervals.

9. The MDF shall have 1 ½ inch solid steel bar stringer style cable runway, finished in Yellow Zinc Dichromate (UL Classified). Rated at 217 lbs./ft supported at 5 ft intervals.

B. Manufacturer: Chatsworth, B-Line, Homaco, and Square D.

2.04 Integrally Fire Stopped Sleeves

A. Materials

B. 3” split square tube with mounting plates and intumescent pads

C. Ganged assemblies for multiple sleeve installation where required

D. UL listed for penetration rating required

E. Radius control modules at both ends

F. See Section 07270 for additional requirements

G. Manufacturers

H. Specified Technologies, Inc., EZ-Path

I. No known equal

2.05 Inner duct – Outside Plant

A. Materials

1. A flexible textile inner-duct shall be placed in all conduits where fiber optic cables are to be placed. A flexible fabric shall provide a minimum of 9 equally sized cells in a 4” conduit as defined on construction drawings. The 3-pack cell shall have color coded stitching and a maximum co-efficient of friction of .08. Each cell shall be shall contain a 1250 lbs. pull tape.

2. The cell packs shall be terminated using an inflatable bag termination system in manholes. (Part # MXCITB4)

3. The cell packs shall be terminated using a split 9-hole duct termination plugs in building applications. (Part # MXCTP4)


B. Manufacturer: TVC Communications MaxCell®, Monarch Flex Pull, Federal Mogul cable

2.06 Surface Raceways

A. Materials

1. The raceway opening shall be a minimum of 1.51” wide by 0.94” with an area of 1-in² serving a maximum of two (2) stations. If more than two (2) stations are being served, the minimum size raceway is 4.07” wide by 1.77” with an area of 5.15-in² and otherwise sized to fit the required number of cables at a maximum of 40% fill rate.

2. The raceway shall be equipped with all accessories such as elbows, tees, junction boxes, bend
radii control pieces, and covers necessary to provide a complete and high quality installation. When both power and communications share a surface raceway, proper bridging accessories shall also be used.

3. The raceway material shall meet or exceed UL-5A standards and shall be equipped with a single piece cover or a snap-in-place cover designed to fasten securely.

4. The raceway must be attached to the walls with mechanical fasteners every six feet in addition to any mastic provided as part of the product

5. Manufacturers:

6. Panduit LD10 Series Surface Raceway System.

7. Panduit T70 Surface Raceway System

8. Hubbell MediaTrack9 Raceway System

B. Wiremold Series 2900L8 Latching Raceway

2.07 Cable Runway and Runway Hooks (OSP)

A. Cable racking, S brackets, and rack hooks shall be hot dipped galvanized. Anchor bolts and anchors shall be ½-inch by 3-inch.

B. Manufacturer: B-Line, CPI or approved equivalent

2.08 Extra Large Building Entrance Frame Systems (XLBET)

A. Materials

1. The XLBET frames shall have a self-supporting base that is designed to be anchored to the floor.

2. The XLBET frames shall be 24” wide, 6” deep and 7’ high.

3. The XLBET frames shall be rated for 1000 pounds distributed weight.

4. The XLBET frames shall be double-sided.

5. The XLBET frames shall be equipped with (18) 100 pair protector blocks on the backside and (12) 300 pair 110 connecting blocks on the front side.

6. Frames shall be manufacture finished in Black (UL Classified).

B. Manufacturers: Chatsworth, Marconi, Circa, and Systimax Solutions

2.09 Enclosed Cabinets

A. Materials

1. When specified in the drawings, these cabinets shall be freestanding four post type cabinets.

2. The cabinet should be a minimum of 24” wide X 36” deep X 84” high, constructed of aluminum or steel tubing. Rack rails shall be 19” apart for mounting of equipment. Rack rails shall have RMU markings. Rails shall be compatible with 12/24 screws, M6 cage nut, or other specified type of attachment.

3. The cabinet should have a fan with the appropriate top and/or side panels to accommodate the fan
4. The cabinet shall be equipped with a floor-mounting bracket; shall have a static load rating of 2000lbs; shall have integral wire management.

5. Equip the cabinet with a 24” perforated metal door with lock in front and back and 24” X 84” side panels.

6. The cabinet should have an 8-outlet, 20A, power strip.

B. Manufacturer: Chatsworth Products Inc., Southwest Data Products, Zero PFT or equivalent.

2.10 Wall Mounted WAP Enclosures

A. Materials

1. To be provided for every wireless access point outlet (Type D)

2. The enclosure shall accommodate a wireless access point device no smaller than 11” X 8” X 2”.

3. The enclosure shall be installed and drilled as required for cables or antennae. Locations shall be coordinated with the wireless access point vendor and the University.

B. Manufacturer:

C. Chatsworth Products Inc., Mini Wireless Wall Enclosure The AAT-MWME-P

D. Panduit Corporation, PZWIFI6

E. Approved Equal

2.11 Protector Panels

A. Materials: Interbuilding and entrance cables shall be protected by 100 pair protector panels equipped with 5 pin UL listed protector panels and units. Protector units shall be gas-tube containing two-electrode high amperage ceramic non-radioactive surge arrestors and a fail-safe mechanism. Protector units shall have a 20-ohm heat coil and be rated for 300 volts. Protector units shall meet Telcordia specification GR-1361-CORE. Protector panels shall to be placed as noted on construction drawings and details.

B. Protector panels within the MDF or as shown on construction drawings shall be rack mounted 300-pair XLBET style units. XLBET shall be available with or without 110 cross-connect blocks.

C. Manufactures: Marconi PROT300XLBET; Circa RMP300XLBET; or approved equal.

D. Protector panels within the BDF or as shown on construction drawings shall be wall mounted 100-pair stub-in/stub-out style with the output stub terminated on rack mounted voice 110 cross connect system as defined in 2.25A.

E. Manufactures: Circa 1900A1-100 or approved equal

2.12 Equipment Racks

A. Materials

1. The BDF and each IDF shall be equipped with one or more 7” high, by 19” wide equipment racks
2. The frame shall be of high strength 6061-T6 bolted aluminum construction and shall meet ANSI/EIA-310 D standards for equipment support frames and UL listing 22Y9. (Min. weights capacity 750 LBS.).

3. Floor-mounted frames shall have a self-supporting base designed to be anchored to the floor and braced for seismic zone 4.

4. Each equipment rack shall be equipped with a minimum 6” front and back vertical wire managers as defined in other sections. Wire manager will be mounted on both sides of all the installed racks.

5. Equipment racks will have factory marked Rack Mount Unit spacing's.

6. Racks shall be manufacturer finished in Black (UL Classified)

B. Manufacturers: Chatsworth, Newton, and Homaco.

2.13 Splice Cases – Indoor Copper

A. Materials

1. All indoor splices shall be contained within an approved splice case designed for multiple closures. The splice case shall be flame retardant, indoor rated.

2. All end plates shall be designed for the number and size of cables served by the splice case.

3. All cases shall be equipped to provide a continuous bond of cable shields through all splices.

B. Manufacturer: Preformed Line Products Armadillo or approved equal.

2.14 Splice Cases – Indoor Fiber

A. Materials

1. All indoor splices shall be contained within an approved splice case designed for multiple closures. The splice case shall be flame retardant, indoor rated.

2. All end plates shall be designed for the number and size of cables served by the splice case.

3. The fiber splice closure shall seal, bond, anchor, and protect fiber optic cable splices.

4. The splice closure shall be a standalone closure that does not require an outer closure.

5. The splice closure shall provide for a maximum of six (6) cable entries in a butt-end configuration.

B. Manufacturer: Preformed Coyote Closure Series, 3M- 2178, or approved equivalent.

2.15 Splice Cases – Outdoor Copper

A. Materials

1. All outdoor splices shall be RUS Listed as Underground (Manhole) Splice Closure for Copper Cables (pressurized) re-enterable units full dressed and enclosed to fit the number and type of cables terminated.

2. The cases shall be leak proof to restrict the movement of fill compound from the outdoor cable.
3. All splices shall utilize Systimax or 3M 710-splice modules. Cable shields shall be bonded through all splices.

B. Manufacturer: Preformed Line Products Armadillo Series, 3M Company (510 version), Communication Technology

2.16 Splice Cases – Outdoor Fiber

A. Materials

1. The outdoor splice case shall be sized appropriately for the number of fiber strands in the spliced cable. The closure is a fiberglass-reinforced, bolted, polypropylene enclosure.

2. All outdoor splices shall be re-enterable units (RUS type 1) full dressed and enclosed to fit the number and type of cable terminated.

3. All splices shall utilize UC-RR fiber optic organizers.


2.17 Fiber Optic Terminal Panels

A. Materials

1. The fiber optic terminals (FTU)/patch panels shall be cable of terminating thirty-six (36) fiber strands per Rack Unit (RU) whether in 1, 2 or 4 RU configurations. Enclosures shall protect fiber optic connections for patching or splicing requirements.

2. The FTU shall provide cross-connect, inter-connect, and splicing capabilities and contain the proper troughs for supporting and routing the fiber cables/jumpers.

3. The FTU shall consist of a modular enclosure with retainer rings in the slack storage section to limit the bending radius of fibers.

4. The FTU shall have a “window” section to insert connector panels for mounting of connectorized fibers (SC style couplers and connectors).

5. The FTU shall provide terminating capability of couplers, in the quantity required by the contract drawings, in panels of 6 or 12 respectively.

B. Manufacturer: SYSTIMAX iPATCH 600B with sliding fiber optic shelf, SC Duplex Connectors, iP-600B-12-CSSC-SMF

2.18 Fiber Optic Couplers

A. All fiber optic couplers shall be SC/UPC, except as noted.

1. Operating Temperature: -40º to 140ºF

2. Insertion Loss: <0.3 dB typical

3. Return Loss: < -55db typical

B. Simplex SC/APC fiber optic couplers shall be used where indicated on the drawings and in other construction
1. Operating Temperature: -40°F to 140°F
2. Insertion Loss: <0.3 dB typical
3. Return Loss: >26dB

C. Fiber Optic Couplers used in FTUs shall utilize pre-configured adapter plates. The adapter plate shall be from the same manufacture as the FTU. The adapter plates shall accommodate up to twelve (12) individual terminations.

2.19 Fiber Optic Connectors

A. Fiber optic connectors used on OSP, riser, and the telecom room end of horizontal fiber optic cable shall be field terminated “puck & polish” type connectors that require field polishing or fusion spliced factory terminated pigtails. Connectors at the workstation end of the horizontal cable maybe pre-terminated no-epoxy/no-polish type connectors; LightCrimp, CamLock, or similar type.

B. Fiber optic connectors at the workstation outlet shall be duplex LC connectors. Fiber optic connectors designated for use in the CATV system shall be SC/APC connectors. All other fiber optic connectors shall be SC type connectors.

C. Connector specifications shall be as follows:
   1. Insertion Loss: < 0.2 dB @ 1300 nm typical
   2. Return Loss >-25 dB typical
   3. Connector Durability <0.2 dB change after 500 matings
   4. Ferrule: zirconia ceramic
   5. Housing: thermoplastic, Beige (MM) Blue (SM)

D. SC/APC fiber optic connectors shall be used where indicated on the drawings or within other contract documents.
   1. Return Loss: >-55dB
   2. Insertion Loss: 0.3dB typical
   3. Connector Durability <0.2dB change after 500
   4. Ferrule: ceramic
   5. Housing: thermoplastic, Green

E. Manufacturer: Structured Cabling Manufacturer

2.20 Cable Tags and Splice Case Labels – Inter-Building

A. Materials:
   1. Plastic identification tags with cable type and number, copper pair or optic number assignments, and destination shall be provided on both ends of all cables and all splice cases. All cables shall be clearly labeled with cable number and size at each end of the cable, when it enters or leaves a conduit and at 30-foot intervals when run are in accessible areas such as manholes, ceilings, etc. Cable tags shall indicate the cable information as shown on the inter-building drawings for copper
and fiber cables and be compliant with Exhibit 16720-B “Label Grammar.”


2.21 Cable Tags and Splice Case Labels – Intra-Building

A. Materials:

1. Metal or heavy plastic identification tags with cable type and number, copper pair or optic number assignments, and destination shall be provided on both ends of all raiser cables and all splice cases. Station cables shall be labeled with self-laminating adhesive laser labels at both ends.

2. All riser cables shall be clearly labeled with cable number, cable counts, cable type, and cable size at each end of the cable and when it enters or leaves a conduit. Cable tags shall indicate the cable information as shown on the Intra-building and riser drawings for copper and fiber cables, and be compliant with Exhibit 16720-B “Label Grammar.”


2.22 Outlet Labels

A. Materials:

1. All labels shall be made using a label maker that produces clear adhesive labels with black typeset characters. The labels shall have a strong adhesive that will not come off unless it is forced off. The label size will be 3/16 inch wide with a typeset font no smaller than 10 point. The Contractor shall utilize the label maker and labels that are recommended for the selected Structured Cabling System.

2. The Contractor shall submit a sample label to the University for approval prior to labeling the new outlets.

3. The labels on each faceplate shall contain the information specified in Exhibit 16720-B “Label Grammar.”

4. The numbering for all cables will be consecutive and sequential on each floor or by termination locations (BDF/IDF).

2.23 Splicing Bay and Relay Rack Labels

A. Materials:

1. Self-adhering 1 1/2" inch high by 1" inch wide black letters and numbers on white background shall be provided in all splice bays in the vault and all equipment racks in the Telecom Rooms.

2. The labeling schemes shall conform to Exhibit 16720-B “Label Grammar” and the information shown on the construction drawings and the detail drawings for the MDF buildings.

3. The numbers and letters in the vault shall be placed mid-distance between vertical rack supports at a height of 36 inches above finished floor.

4. The numbers and letters on the relay racks shall be placed on the horizontal, top cross member, midway between vertical sides.

B. Manufacturer: Tech Products Inc., 3M (5000 Scotchlite) Decal System, Panduit or approved equal.

2.24 Communications Backboards
A. The Contractor shall provide 3/4" A/C void-free plywood as noted on drawings. The backboard shall be sized as noted on the contract drawings and shall be a minimum of 4' by 8'. Plywood shall be extended from 2' A.F.F. to 8'-2" A.F.F. and wall-to-wall unless noted otherwise by the Owner’s representative.

B. Plywood shall be fire retardant or treated with fire-retardant sealant or covered with a fire-retardant paint. All backboards shall be finished sanded, sealed with a primer and finished with two coats of paint. This requirement is campus and local fire code specific.

2.25 Jack Modules/Connectors

A. Modular RJ45 jacks
   1. See Exhibit 16720-A “Outlet Configurations” for work area outlet details.
   2. All modular RJ45 jacks shall have the following properties:
   3. Shall be designed to exceed the TIA/EIA-568-B.2-1 Category 6 and ISO 11801 2nd Edition Class E standards, plus the headroom requirements of the station cable
   4. ETL tested and approved for Category 6 component compliance
   5. 100% tested to ensure NEXT performance
   6. Terminate 4-pair 24-22 AWG 100 ohm solid unshielded twisted pair cable
   7. Module is color coded for T568A and T568B wiring schemes
   8. Accepts 6 and 8 position modular plugs without damage
   9. Compatible with selected Solution’s patch panels, faceplates and surface mount boxes
   10. Compatible with legacy patch panels, faceplates and surface mount boxes.
   11. Compatible with Keystone style patch panels, faceplates and surface mount boxes.

B. Manufacturer: Structured Cabling System Manufacturer

2.26 Faceplates

A. Faceplates will be supplied for every information outlet (voice, data, and network). Unless otherwise noted, they shall meet the required NEMA standard.

B. Faceplates shall be available in single, duplex, or six-port arrangement in a single gang configuration.

C. Faceplates shall be available in eight-port or greater arrangement in a dual gang box configuration.

D. Surface mount boxes shall be available in single, dual, six and eight-port configuration.

E. The faceplate color shall be Electrical Ivory unless other wise specified on the construction drawings.

F. Faceplates shall be compatible with wall and floor mounted outlet boxes.

G. Manufacturer: Selected Structured Cabling System

2.27 Copper Cable Termination Blocks
A. Materials

B. The voice termination blocks shall have the following properties:

1. Building Entrance Terminal tails, riser cable and voice 4-pair UTP Category 6 station cables shall be terminated on 110 high-density Category 6 patch panel system. The 110 high-density Category 6 patch panel system shall support high bandwidth applications including but not limited to 1Gbps Ethernet.

   a. The 110 high-density Category 6 patch panel system shall incorporate a lightweight structural foam back panel. The footprint of the back panel shall be the same as traditional 110-system wall mounting hardware but shall be capable of 336 conductor pair terminations instead of the traditional 300 conductor pairs. The 110 high-density Category 6 patch panel system shall facilitate the stacking of three panels to create a vertical field capable of 1008 termination of conductors versus the 900 terminations of traditional systems.

   b. All 110 high-density Category 6 patch panel system components shall snap together without the use of tools. In addition to lightweight structural foam back panel, the system shall consist of the following:

      c. High-density 110 wiring block

      d. A back panel that shall hold twelve snap-in 110 wiring blocks. The snap-in wiring block shall terminate up to 28 pairs per row. The high-density 110-wiring block shall utilize traditional IDC conductor spacing.

      e. The back panel shall be rack mounted in a 19” equipment rack as indicated on construction drawings.

      f. Each high-density wiring block shall utilize a snap-on cover plate for cable termination protection and for labeling of the conductor pairs/cables.

      g. Distribution rings for vertical cable management shall snap into the sides of the structural foam back panel. Wiring block shall be fitted with manufacture recommended number of distribution rings.

      h. Wiring block shall be compatible with legacy 110 tools and test equipment

      i. Manufacture: Systimax VisiPatch system; no known equal.

2. The data patch panels shall have the following properties:

   a. Utilize modular jack termination with snap-in modules; port counts as indicated on contract drawings. Twenty-four (24) port patch panels will be 1 Rack Unit high, and forty-eight (48) port patch panels will be 2 Rack Units high. Modular jack specification per Section 16720 2.24 D. Individual modular jack color shall match the modular jack color at the workstation end of the cable.

   b. Be of an angled design that allows cable to flow to each side of the rack

   c. Allow labeling scheme and port identification to be visible at all times

   d. Allow front access to installed modules

   e. Mount to standard TIA/EIA 19” rack or 23” racks with optional extender bracket

   f. Compatible with Panduit Patch Runner Network Cable Management System
g. Empty patch panel ports shall be filled with blank modules

h. Manufacture: SYSiMAX m4200i Intelligent Universal Modular Patch Panel (ip-m4200i-24) or approved equal.
3. Coax patch panels shall conform to the specification outlined in Section 16740 2.7.

4. All patch panel assemblies shall include wire retention clips as specified by the selected Structured Cabling System supplier.

5. Provide and install appropriate wire management as specified by the selected Structured Cabling System suppliers and on construction drawings.

6. The proper size retaining clips shall be used for all cable terminations (e.g., four-pair for stations and five-pair for riser, interbuilding, and entrance).

7. All materials shall be labeled according to Exhibit 16720-B "Label Grammar."

2.28 Wire Management

A. Materials

1. All equipment and fiber optic panel frame racks shall be equipped with vertical and horizontal wire management organizers as outlined in the design documents.

2. All wire managers shall be secured to the frames and shall provide a clear and unobstructed pathway in which to route the cables.

B. Vertical Wire Managers

1. Vertical wire managers shall be a minimum of six inches wide and have pathways on both the front and back of the unit. The manager shall have a metal door that will be capable of opening to the left or the right when mounted.

2. All vertical wire managers shall be equipped with patch cord slack management spools.

3. All vertical wire managers shall be heavy duty painted metal with pass through holes with rolled edges that provide bend radius control and plastic cable management fingers that align with EIA rack spacing and designed specifically to be connected to equipment frames.

4. When mounted between two equipment frames, they shall be designed to direct cables into either frame and shall be securely mounted to both units.

5. These organizers shall be designed to extend past the frame to allow placement of the equipment in any position within the rack. The fingers shall be molded out of plastic and incorporate bend radius control throughout the entire length.

6. Manufacturers: Panduit Patch Runner PRV6, or approved equivalent.

C. Horizontal Wire Managers (Equipment racks)

1. Horizontal cable managers shall include components that aid in routing, managing and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19" or 23" racks and constructed of lightweight plastic with PVC duct attached. The duct fingers shall include retaining tabs to retain the cables in place during cover removal.

2. Horizontal cable managers shall have removable front cover hinges 180° up or down

3. Horizontal cable managers shall have pass through holes and curved surfaces to protect cable and preserve cable bend radii.

4. Manufacturers: Equipment Rack Manufacturer (see 2.27)
PART 3 – EXECUTION

3.01 General Installation

A. All installation work shall be performed according to published industry guidelines, rules, and regulations. All Structured Cabling System products shall be installed according to manufacturer procedures.

B. All pathways shall avoid electromagnetic interference (EMI). Cable that is distributed in partially-enclosed metallic pathways shall be routed with the following minimum clearances:
   1. Four (4) feet from motors or transformers.
   2. One (1) foot from conduit and cables used for electrical power and distribution.
   3. Five (5) inches from fluorescent lighting.

C. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables and conduit.

3.02 Hangers and Cable Ties

A. In suspended ceiling and raised floor areas where cable trays or conduit are not available, station wiring shall be bundled with plastic cable ties or Velcro wraps at appropriate distances.

B. Tie wraps shall not be over tightened to the point of deforming or crimping the cable sheath.

C. Hangers supporting the cable bundling shall be attached to the existing building structure and framework.

D. Hangers shall not be attached to suspended ceiling supports, T-bar, or bracing.

E. Hangers shall be installed to provide at least 3 inches of clear vertical space between the cable bundling and the ceiling tiles.

F. Hangers shall be spaced at alternating 4' and 5' distances to prevent cables from sagging or buckling.

3.03 Cable Runway

A. Cable runway shall be placed so that fully loaded runways shall not obstruct or impede the operation of lighting, air handling systems, and fire extinguishing systems. Ladder racking shall be supported at no greater than 5-foot spans and seismic braced to Zone 4 by manufacture recommendations.

3.04 Innerduct

A. The appropriate amount and size of Maxcell innerduct shall be installed for maximum conduit utilization per manufactures recommendations and contract drawings.

B. Cable racking and rack hooks shall be provided in all new utility vaults. Utility vault manufacturer to provide all racking bonding and ladder in all new vaults.

3.05 Raceways

A. All surface-mount raceways must be mechanically secured to the structure a minimum of every six feet.

B. Raceways must be routed at right angles to nearby structures or wall corners, and shall be neatly installed and trimmed to fit into and around other existing moldings or pathways such as the ceiling area.
C. Raceways shall be placed vertically only in corners of rooms and horizontal raceway placed at baseboard height to extend the cable run to the actual outlet location.

D. Raceways shall be routed to avoid interference, using standard sections and a minimum number of field-cut sections.

E. Raceways shall be routed to avoid interference with removal and installation of lighting fixtures and devices of other systems that require servicing or operation.

F. Sharp burrs or edges shall be removed from raceways.

G. Completed raceways shall have no cracks or openings at coupled sections.

H. Raceway supports:
   1. Overhead Supports: Raceway shall be supported from concrete ceiling or ceiling beams, at five (5) feet maximum span intervals, using 3/8 inch threaded rods with c-hangers.
   2. Raised Floor Installation: Raceway shall be provided to accommodate under floor pedestals at four (4) foot maximum span intervals.
   3. Overhead c-hanger and under floor support details shall be designed to provide complete cable lay-in capability.

I. Strict adherence to the CEC/NEC NFPA 101 is required for any raceway penetrations of fire-rated walls. See section 07840 for UL system numbers and to construction drawings for details.

J. Radius fittings shall be provided for turns and offsets to accommodate obstructions or elevation changes and maintain minimum cable bending radii.

3.06 Splicing

A. Any splice case placed within a building shall be an indoor rated (fire retardant) case. All splice cases placed in the underground shall be a pressurized RUS listed for underground use.

B. Splice cases or enclosures shall have a hard outer shell (either metal or hard-molded plastic) for mechanical protection to the splice and sealed end plates.

C. All splice work shall be neat and orderly, with no defective pairs accepted in any cable placed.

D. Both the cable and the splice case shall be affixed to the wall of the vault in an orderly fashion using galvanized hooks and in a location agreed upon between the Owner’s representative and the Contractor.

E. All cables shall be bonded through all splices; however, final grounding of the interbuilding cable in the vault shall not be made until after end-to-end cable tests have been conducted.

F. All splices shall be inspected before closure, and when approved, shall be wrapped, and then sealed. All splices not within a building shall be fully sealed ONLY AFTER THE OWNER’S REPRESENTATIVE PROVIDES WRITTEN ACCEPTANCE OF INSPECTION AND TEST RESULTS.

G. All splice cases shall be bonded to ground with a 6 AWG ground wire.

3.07 Fiber Optic Terminal Panels

A. Final location of FTUs shall be coordinated with the Owner's representative.
B. Rack-mounted fiber panels shall be mounted at the top of the rack.

C. All cables mounted into fiber optic panels shall be installed and secured as defined by the manufacturer using the tools, materials, and techniques outlined by the manufacturer.

D. All fiber optic panels shall have integral wire management troughs for routing of fiber patch cords and/or jumpers.

E. All fiber optics shall be terminated to selected Structured Cable Solution specifications using Duplex SC type connectors and adapters. Single mode fiber optic cable strands specifically designated as CATV fiber shall be fusion spliced to a jumper (pigtail) with a factory terminated SC/APC connector and an appropriate simplex SC/APC adapter.

F. All data network fiber optic connectors shall be mounted using the Symmetrical Positioning Method to maintain fiber polarity. All CATV fiber shall be mounted in the standard sequential manner, by color code.

   1. Symmetrical Positioning Method: Adapters are inserted in the patch panel at one end of the cable with the opposite orientation of the adapters at the other end of the cable. At one end of the cable, adapters are installed such that adapter position A corresponds to odd numbered panel positions (A-B, A-B order), and on the other end of the cable, adapters are installed in the opposite orientation such that adapter position B corresponds to odd numbered panel positions (B-A, B-A order).

   2. Utilizing Duplex SC adapters, at the MDF end of the cable (Bldg 41/A or Bldg 11), connector clips will be up or right (dependant on FTU style) and at the project building end of the cable the connector clips will be down or left (dependant on FTU style).

   3. Fibers are plugged into the adapters with the same number (or color code) sequence on both ends of the cable (that is, 1 (blue), 2 (orange), 3 (green), 4 (brown), etc.) so that the fiber number (or color code) sequence is symmetric with respect to the panel positions.

3.08 Cable Tags and Labeling

A. The Contractor shall legibly label all voice, data, and video outlets, cable, blocks, frames, and patch panels per the Owner’s representative directions and as defined herein.

B. The Contractor shall employ a cable labeling and tagging scheme that meets TIA-606A specifications and is compliant with Exhibit 16720-B “Label Grammar.”

C. Construction labels shall be installed on all cables as they are pulled. Each cable shall have a unique number that shall be related to the appropriate faceplate number and jack letter.

D. A label shall be installed on each conduit attached to a communications wall box and shall be affixed to the end of the conduit near the cable tray. The label shall have a unique number related to the appropriate faceplate number and jack letter.

E. Labels shall be installed on all station cables within two (2) inches of the end of the outer jacket material within the back box and at the blocks/patch panel. Typed labels on self-sealing tape, with a plastic overlay, shall be used. Each cable shall have a unique number that shall be related to the appropriate faceplate number and jack letter.

F. Labels shall be installed on all patch panels, blocks, and both the inside and outside of all faceplates. A uniquely numbered label for each faceplate and a unique letter for each jack shall be supplied and installed. The labels shall be machine printed (not embossed) on vinyl tape using a Brothers label maker or equivalent. The labels shall have protective overlays.

G. Labels shall be numbered according to a scheme developed in consultation with the Owner’s representative and in accordance with TIA/EIA-606A and Exhibit 16720-B “Label Grammar.”
H. Ground Bars

1. The main ground bar shall be labeled as such.
2. Each subsidiary ground bar shall be labeled as such and have a unique identifier.
3. All ground bars shall have a warning label that states, “If this connector or cable is loose or shall be removed, please call the Telecommunications Manager.” All ground bars will be connected to the building ground with continuous “0” AWG wire.
4. Each ground cable shall be labeled with a unique identifier.

I. Labels shall be installed on all OSP cables at each termination or splice point, at each entrance and exit from a conduit, manhole, or service loop.

3.09 Station Outlets

A. Voice/Data/Data Outlets (Type A)

1. The standard voice/data/data outlet shall consist of three (3) Category 6 four-pair cables, each terminated on a separate Category 6 rated RJ45 8-position jack following T-568 B wiring standards. One jack will be Electrical Ivory for voice, Orange for the primary data (DATA 1), and Green for the secondary data (DATA 2).
2. The faceplate will be clearly labeled with outlet (IOT) number, and each jack will be labeled with jack number. All labels will be typed or preprinted and shall be securely affixed to the faceplate. The label format shall conform to the CSUMB Label Grammar; see Exhibit 16720-B.
3. Dust covers shall be placed in the vacant slots
4. Manufacture: Structured Cabling Solution Manufacturer

B. Voice/Data/Data/Coaxial/Fiber Outlets (Type B)

1. The standard voice/data/data outlet shall consist of three (3) Category 6 four-pair cables, each terminated on a separate Category 6 rated RJ45 8-position jack following T-568 B wiring standards. One jack will be electrical Ivory for voice, electrical Orange for the primary Data 1 and Green for the secondary Data 2, One RG6 coaxial cable terminate on a F-81 connector and two (2) strands of MM fiber terminated on an LC duplex connector.
2. The faceplate will be clearly labeled with outlet (IOT) number, and each jack will be labeled with jack number. All labels will be typed or preprinted and shall be securely affixed to the faceplate. The label format shall conform to the CSUMB Label Grammar; see Exhibit 16720-B.
3. Manufacture: Faceplate, Structured Cabling Solution Manufacturer

C. Data Only Outlets (Type C#, where #= number of jacks/cables)

1. The data only outlets shall consist the number indicated after the ‘C’ of RJ45 8-pin modular jacks wired per wiring standard T-568 B and dust covers in an ivory quad outlet faceplate. The number of terminated cables at each outlet shall be according to floor plan drawings. Jacks shall be electrical Orange in color for the odd numbered ports and Green in color for the even numbered ports.
2. The faceplate will be clearly labeled with outlet number, and each jack will be labeled with jack number. All labels will be typed or preprinted and shall be securely affixed to the faceplate. The label format shall conform to the CSUMB Label Grammar; see Exhibit 16720-B.
3. Manufacture: Structured Cabling Solution Manufacturer
D. Wireless Access Point Outlets (Type D)
   1. WAP only outlets shall consist of a single four-pair Category 6 cable terminated to an 8-pin RJ45 modular jack assembly. The color of the jack will be Orange.
   2. The jack will be mounted in a single port surface mount box, which will be clearly labeled with the outlet number and the jack number. All labels will be typed or preprinted and shall be securely affixed to the faceplate. The label format shall conform to the CSUMB Label Grammar; see Exhibit 19720-B.
   3. Manufacture: Structured Cabling Solution Manufacturer

E. Voice Only Outlets (Type W)
   1. Designated wall phone locations shall be wired with one category 6 cable terminated on a wire 8-pin, RJ45 modular jack assembly equipped with a metal face place suitable for securing a wall mounted telephone. The color of the jack shall be designated by the manufacture of the wall-phone mounting bracket and the color of the cable shall be white.
   2. All Wall phone outlets shall be placed at 44 inches above the finished floor unless otherwise noted to make the maximum height to the top of the telephone 48 inches above the finished floor.
   3. Manufacture: Structured Cabling Solution Manufacturer

F. Floor-Mount Voice/Data/Data Outlets
   1. The voice/data/data floor-mount outlet shall consist of three (3) Category 6 four-pair cables, each terminated on a separate RJ45 8-pin jack following wiring standard T 568 B.
   2. The communications portion of the outlet shall be equipped with a NEMA standard duplex faceplate cutout and three RJ45 jacks.

G. All station outlets shall be terminated in the IDF that is on the same floor as the station outlet.

H. Station outlets shall not be “daisy-chained” except for one Type J outlet vertically aligned with another data outlet within the same room and wall.
   1. Standard voice/data outlet: 18 inches, on center, above the finished floor.
   2. Wall-mounted video outlet: 78 inches above the finished floor.
   3. Counter top: 6 inches above the counter top.

I. Wireless Access Point Outlets
   1. Outlets designated on the construction drawings as Type D outlets, shall be installed in a single port surface mount box and mounted at +9’ above finished floor, unless other wise noted.
   2. Type D outlets shall be installed with a 3-meter slack loop of cable, neatly coiled and mounted at the outlet location.
   3. Special consideration may need to be taken for mounting the outlet, depending on the field conditions, especially in open ceiling environments. Verify with University representative before mounting.
   4. Type D outlets shall be identified and labeled as specified in Exhibit 16720-B “Label Grammar”.

3.10 Faceplates (IOT)
A. The faceplates shall be configured to hold the exact number of jacks called for at each location (e.g., 3 jacks, 3 port faceplate). If there is not a faceplate available for that count, the next size up is acceptable (e.g., 5 jacks, 6 port faceplate).

B. All faceplates shall be single-gang unless otherwise noted in the contract drawings.

C. The faceplates shall be identified and labeled as specified in Exhibit 16720-B “Label Grammar”.

D. The faceplates shall have their jack positions labeled as specified in Exhibit 16720-B “Label Grammar”.

3.11 Copper Cable Termination Blocks

A. All 110 terminal blocks shall be clearly and neatly labeled with outlet (jack) or pair assignments.

B. All outlets shall be numbered sequentially in the closet using a numbering assignment agreed upon with the Owner’s representative and in compliance with Exhibit 16720-B “Label Grammar.”

C. All riser, tie, and data terminals shall be numbered using pre-printed identification strips. The Owner’s representative shall determine numbering methodology unless otherwise noted.

D. All terminal locations shall be approved prior to installation.

E. All work on terminals shall be accomplished using tools and support hardware designed for the 110 system and following procedures identified by the manufacturer.

3.12 Equipment Racks

A. Each IDF and BDF will be equipped with at least one (1) 19-inch equipment rack. Some IDFs/BDFs may require more than one and will be noted on construction drawings. Wherever possible, allow a 36” wide aisle way in the front and in the rear of each equipment rack.

B. All racks in telecom spaces (MDFs, BDFs, IDFs), new or existing, will be anchored through the raised access flooring to the floor per the manufacturer’s recommendations to comply with the California Building Code.

C. All racks will be labeled in compliance with Exhibit 16720-B “Label Grammar.”

D. All equipment mounted in the racks (i.e. patch panels, wire management, electronic equipment) shall be mounted with the appropriate sized screws. Screws will be installed by hand using a screwdriver, not by using a drill or electric screwdriver. This is to prevent cross threading and/or stripping of the screw heads.

E. All equipment racks shall be individually bonded to the TMGB or TGB located within the room.

3.13 Pull Boxes and Cabinets

A. Pull boxes shall be installed in easily accessible locations.

B. Pull boxes installed as part of a horizontal cabling pathway shall be installed immediately above suspended ceilings, where possible.

C. Pull boxes shall not be used for splicing cable.

D. Pull boxes shall be placed in conduit runs that exceed 100-feet or which require more than two 90-degree bends. The pull boxes shall be located in straight sections of conduit and shall not be used for a right angle bend. Installation shall allow cable to pass through from one conduit to another in a direct line.
E. Pull boxes shall have a length at least twelve (12) times the diameter of the largest conduit.

3.14 Wire Managers
A. Both vertical and horizontal wire managers shall be located on each equipment rack in all BDFs and IDF as shown on construction drawings details. Wire managers are to provide a clear and unobstructed pathway to route jumper wires. In the MDFs the XLBET frames shall only be equipped with horizontal wire managers.

3.15 Data Network Patch Panels
A. All data station cables shall be terminated on rack mounted, angled modular jack patch panels. All data station cables shall be terminated to TSB 568B wire scheme. Data station cables are to be routed from the entry point in BDFs or IDF along the ladder racking in a neat and orderly way, bundled together and protected from damage or distortion.

B. All patch panels will be labeled in compliance with Exhibit 16720-B “Label Grammar.”

C. All patch panels shall be bonded to the rack they are mounted in, using a combination of bonding screws and/or washers.

3.16 Protector Panels
A. All interbuilding copper cables shall be equipped with protector panels and protector units. The protector panel tails shall to be spliced to the entry cables and encased in an indoor rated (fire retardant) type splice case. Protector panels shall be placed on XLBET type frames in all MDFs or as required by contract drawings.

3.17 Enclosed Cabinets
A. Enclosed cabinets shall be placed as noted on construction drawings. These cabinets shall be equipped with a topside fan and louvered sides to allow airflow to cool electronic equipment. These cabinets shall be hinged on one side to allow access to backside of equipment rack. Cabinets shall be anchored through raised access flooring to the structural slab per the manufacturer’s recommendation to comply with the California Building Code.
Exhibit 16720-A — Outlet Configurations

4 PAIR CAT 5 CABLES FROM SERVICE TELECOM ROOM, MAINTAIN TWIST TO WITHIN 1/3" OF TERMINATION POINT (TYP)

SIX PORT FACEPLATE

MODULAR JACK, 8 PIN COND. T568B CAT 5, INSERT TAB DOWN, ELECTRICAL IVORY

SERVING ROOM ID (TS-alphanumeric)

THIS OUTLET ID NUMBER (THREE DIGIT NUMERIC)

MODULAR JACK, 8 PIN COND. T568B CAT 5, INSERT TAB DOWN
- LEFT ORANGE, RIGHT GREEN

ALPHANUMERIC JACK ID NUMBER. SEE CSUMB IDENTIFIER GRAMMAR FOR DETAILS (TYP.)

TYPE ‘A’, VOICE/DATA/DATA
Exhibit 16720-A — Outlet Configurations (continued)

SINGLE GANG, MODULAR FACEPLATE

4 PAIR CAT 6 CABLES FROM SERVING TELEDOM ROOM, MAINTAIN TWIST TO WITHIN 1/8" OF TERMINATION POINT.

ALPHA-NUMERIC JACK ID NUMBER: SEE CSUMB IDENTIFIER GRAMMAR FOR DETAILS (TYP.)

MODULAR JACK, 8 PIN COND. T568B CAT 6, INSERT TAB DOWN, ELECTRICAL IVORY

RG-11 COAX STATION CABLE FROM SERVING TELECOM ROOM, TERMINATE PER CSUMB SPECIFICATIONS.

TWO STRAND FIBER OPTIC 50/120 MULTIMODE CABLE FROM SERVING TELECOM ROOM, TERMINATED ON DUPLEX SC.

VIDEO COAX, F-TYPE CONNECTOR, INSERT MODULE COLOR TO MATCH FACEPLATE

BLANK MODULAR INSERT AS REQUIRED (TYP.)

SERVING ROOM ID (TS-alpha-numeric)

DUPLEX LC FO

TYPE ‘B’, VOICE/DATA/DATA/COAX/FIBER
Exhibit 16720-A — Outlet Configurations (continued)

Type 'C', DATA only;
# = number of jacks/cables
Exhibit 16720-A — Outlet Configurations (continued)

TYPE ‘D’, Wall-mount Wireless Access Point location. +96” AFF or as noted.
Exhibit 16720-A — Outlet Configurations (Continued)

Single Port Faceplate

SERVING ROOM ID (TS-[alpha-numeric])

THIS OUTLET ID NUMBER (THREE DIGIT NUMERIC)

1 RG59 coax cable terminated per specifications

ALPHA-NUMERIC JACK ID NUMBER. SEE CSUMB IDENTIFIER GRAMMAR FOR DETAILS (TYP.)

K

TYPE ‘K’, Wall-mount coax TV outlet, +72" AFF or as noted
Exhibit 16720-A — Outlet Configurations (Continued)

Single Port Faceplate

SERVING ROOM ID (TS-[alpha-numeric])

4 PAIR CAT 5 CABLES FROM SERVING TELECOM ROOM. MAINTAIN TWIST TO WITHIN 3/8" OF TERMINATION POINT (TYP)

TS-an

IOT.nnn

THIS OUTLET ID NUMBER (THREE DIGIT NUMERIC)

ALPHA-NUMERIC JACK ID NUMBER. SEE CSUMB IDENTIFIER GRAMMAR FOR DETAILS (TYP.)

aaa.nnn

W

TYPE ‘W’, Wall-phone mount; +48"AFF
Exhibit 16720-B – Label
Grammar
TIA/EIA 606-A Identifier:

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Backbone Cables

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Backbone Pairs/Strands

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Pathways

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<td>PCB Pathway Cabinet</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PCN Pathway Conduit</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PCT Pathway Cable Tray</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PFB Pathway Pull Box</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PRK Pathway Rack</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PRR Pathway Ring Runq</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PSL Pathway Sleeve</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PSL Pathway Slot</td>
</tr>
<tr>
<td>&lt;pathway element descriptor&gt;</td>
<td>PTV Pathway Tray</td>
</tr>
</tbody>
</table>

Connection Hardware

<table>
<thead>
<tr>
<th>Connection Hardware</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;connector hardware&gt;</td>
<td>[{&lt;organization&gt;}[&lt;campus&gt;]&lt;structure&gt;&lt;space id&gt;}] - Copper patch panel 12 in Building 18’s BDF located in telecom space 1A</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>CBF Copper Block Field</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>CCC Copper Cross Connect</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>CPL Copper Patch Panel</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>CPT Copper Port</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>CTM Copper Termination</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>FPL Fiber Patch Panel</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>FPT Fiber Port</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>FTM Fiber Termination</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>XPL Coax Patch Panel</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>XTP Coax Tap</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>XTM Coax Termination</td>
</tr>
<tr>
<td>&lt;connector element descriptor&gt;</td>
<td>IOT Information Outlet (face plate)</td>
</tr>
<tr>
<td>JCK</td>
<td>Jack</td>
</tr>
</tbody>
</table>

Exhibit 16720-B — Label Grammar (continued)
Horizontal Links

<horizontal link> ::= <space><connection element descriptor>.<element#> {.<sub-element#>}

[CSUMB-018-1A]-CBF.12.24 - Four pairs of copper punched down on copper IDC connector (e.g., 110-block) #12, position 24 in telecom space 1A in building 018

External Links

<external link> ::= <space>/<space>-<external link element descriptor>.<element#>.<sub–element#>{(<qualifier>)}

[CSUMB-018-1A]/[FEDNS-011-1A]-OC12.02 - Off-campus connection between room telecom space 1A in Building 18 at CSUMB and telecom space 1A of Building 11 at NPS. Link type is an OC-12 of which this link is the second between CSUMB and NPS.

Busbars

<busbar> ::= <space>-<connection element descriptor>.<element#>

[CSUMB-018-1A]-TMGN

Miscellaneous Objects

<element#> ::= <digit><digit> 32; 03
<sub-element#> ::= <digit><digit> 32; 03
<qualifier> ::= <string-alphanumeric>
<digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
<number> ::= <digit><number>
<alpha> ::= A-Z
<char> ::= <digit> | <alpha>
<string-alpha> ::= <alpha><string-alpha>
<string-alphanumeric> ::= <alpha><string-alphanumeric>
<number> ::= <digit><number>
<spacechar> ::= %20 - A single space character
<null> ::= 

Terminal Equipment

<terminal equipment> ::= <computer equip> | <voice equip> | <network equip>
<computer equip> ::= <computer device><computer mgft><property tag#> PCLMAC-0009109
<voice equip> ::= <voice device><voice type><voice equip#> PRTNET - 0009109
<network equip> ::= <host name> TELDIG-??????
[property tag #] ::= <number> 7 digits
<voice equip #] ::= <number> TBD
<host name> ::= <campus><string-alphanumeric> MB-NMSSUN
<computer device> ::= FAX Fax machine
<pc> ::= Personal Computer
<voice device> ::= Telephone
<voice type> ::= ANALOG, DIGITAL, CELLULAR
<computer mgft> ::= HWP HP-Compaq
<computer device> ::= PCD PC, Desktop
<voice equip#> ::= PCL PC, Laptop
<host name> ::= MB-NMSSUN
<pc> ::= PC Desktop
<voice device> ::= TEL Telephone
<voice equip#> ::= ANALOG, DIGITAL, CELLULAR

Final Record Drawings
03/03/2009
Exhibit 16720-B — Label Grammar (continued)

Information Outlet number. Unique per Telecom Space. 100-199 for 1st Floor, 201-299 2nd Floor, 301-399 3rd Floor, etc.

For Port 3:
CPL.03.26 – Copper Patch Panel 03, position 26
Horizontal Link ID 81.03

For Port 6:
FPL.01.25/26 – Fiber panel 01, positions 25 & 26
Horizontal Link ID 81.06

Telecom Space ID service this faceplate
Exhibit 16720-B — Label Grammar (continued)

SINGLE PAIR, RISER OR OSP CABLE CONFIGURATION

First and fifth pair of each 5 labeled with pair number

Cable Identifier: Copper Cable 01, pairs 1-300

Examples of potential non-number port names

Termination Block Identifier

4-PAIR STATION CABLE CONFIGURATION

Full Identifier: [CSUMB-018-1A]CBF.01.01

Port 13 is connected to position 01 on Information Outlet number 01 in room 144, by a horizontal link named [CSUMB-018-1A]CBF.01.13

The room number (in this example, 144) is added to the termination block labeling only.
The full name for this patch panel is:
[CSUMB-018-1A]CPL.12
Copper patch panel 12 in Building 18's BDF located in telecom space 1A

(building and space designation is not necessary on actual equipment, only included here for clarity)

Port 26
Its full Identifier: [CSUMB-018-1A]CPL.12.26
Port 26 is connected to position 03 on Information Outlet number 02 in room 144, by a horizontal link named [CSUMB-018-1A]CPL.12.26
The room number (in this example, 144) is added to the patch panel labeling only.

Port 25
Full Identifier: [CSUMB-018-1A]CPL.12.25
Port 25 is connected to position 02 on Information Outlet number 02 in room 144, by a horizontal link named [CSUMB-018-1A]CPL.12.25
The room number (in this example, 144) is added to the patch panel labeling only.

Exhibit 16720-B — Label Grammar (continued)
Panel Identification number affixed to the front side of the outer door.
FORMAT:  FPL=Fiber Panel.nn

[aa-na]aaa.nn.nnnn =
[Bl/dg #]-TS]FCA.cable #.strand count
(OSP CABLE LABELING)

In this example:
Fiber Cable 23, strands 1-24 from MDF to Bldg 18

[nnn]aaa.nn.nn.nnnn =
[Room #]IOT.#.faceplate port #
(HORIZONTAL CABLE LABELING)

In this example:
Horizontal Cable 91 to IOT 81 in Room 144,
ports 6, in faceplate IOT 81

TS=Telecom Space as determined by CSUMB IT
FCA = Fiber Cable
Cable # = provided by CSUMB IT

END OF SECTION
SECTION 16721
FIRE ALARM/LIFE SAFETY

PART 1 – GENERAL

1.01 Description

A. Work included in this section:

1. Materials, equipment fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

a. Multiplexed, addressable, analog, microprocessor-based, fully field-programmable, Fire Voice

b. Communication System, as specified herein and as shown on Drawings, including but not limited to:

c. Fire Alarm Control Panels, remote annunciators, remote printer, and all peripheral devices: manual alarm devices, automatic detection devices, audible and visual signaling devices, auxiliary devices, etc.

d. All related system software and custom programming.

e. All required cable, conduit, fittings, etc. for a complete working system.

f. All submittals, shop drawings, as-built drawings, and test reports, including approval of shop drawings by the State Fire Marshall.

B. Related Work in Other Sections:

1. Conduit and Wiring: Basic Materials and Methods Section, Division 16.

2. Installation of duct-mounted smoke detectors, coordination of fan control: Heating, Ventilating and Air Conditioning Section, Division 15.


4. Coordination of electromagnetic door hold-open devices, smoke evacuation doors, hatches and windows: Doors, Hatches and Windows Section, Division 8.

5. Elevator control: Conveying Systems Section, Division 14.

1.02 Reference Standards and Governmental Regulations

A. Requirements of General conditions and Division 1 apply to all work in this section.

B. Published specifications, standards, tests, codes, or recommended standards of trade, industry, or governmental organizations apply to work in this Section where cited below:

ADA - Title 3 of the Americans with Disabilities Act
CCR - Title 19 and 24 of the California Code of Regulation
C. The fire alarm system shall conform to Article 760 of Part 3, Title 24 of the California Code of Regulations.

1. Installation of the fire alarm system shall not be started until detailed plans and specifications, including State Fire Marshal listing numbers for each system component, have been approved by the State Fire Marshal.

2. Upon completion of the installation of the Fire Alarm System, a satisfactory test of the entire system shall be made in the presence of the State Fire Marshal.

1.03 QUALITY ASSURANCE

A. All equipment supplied shall be listed by a nationally recognized fire test laboratory (UL and/or FM) and be listed by the California State Fire Marshal.

B. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture. All items of a given type shall be the products of the same manufacturer.

C. All items shall be of the latest technology; discontinued models or products are not acceptable.

D. The manufacturer, or its authorized representative shall confirm that within a reasonable distance of the project site, there is an established agency that:

1. Stocks a full complement of parts.

2. Offers service during normal working hours as well as emergency service on all equipment to be furnished.

3. Will supply parts without delay and at reasonable cost.

E. The Contractor shall be capable of performing service or maintenance work on the specified or approved systems. The Contractor shall be factory-certified where such certification is available.

1.04 SUBMITTALS

A. Submit the following to the Architect (8 copies required):

1. Manufacturer's names, model numbers, and catalog references for all equipment supplied indicating UL and CSFM listings for all system components.

2. A complete sequence of operations for all functions of the system.

3. A complete listing of all system input and output points. All individual point designations, as well as zone groupings, shall be listed by point (or zone) number and English language descriptor.

4. A complete listing of all evacuation system pre-recorded messages.

5. Complete construction shop drawings, including system riser diagrams, floor plans indicating all device locations, and point-to-point system Wiring diagrams for all components including interfaces.
to equipment furnished by others. Include amplifier power and battery back-up calculations.

6. A complete Bill of Materials.

7. Service information, including the address and telephone number of the nearest service representative.

B. Submittals must be complete. Incomplete submittals may be rejected at the discretion of the owner.

C. The Contractor shall prepare, submit to the California State Fire Marshal and obtain approval for Fire Alarm shop drawings. These shall contain, at a minimum, the following information:

1. Floor plan drawings showing all fire alarm initiating and signaling devices. Include room designations on floor plan drawings.

2. System riser diagram.

3. Point-to-point wiring diagrams.

4. Copies of California State Fire Marshal listing sheets, showing expiration date of listing, for all system components.

5. Manufacturer’s specification sheets for all Fire Alarm equipment.

6. Battery calculations in standby and alarm conditions.

7. Voltage drop calculations for all signal circuits.

8. Symbol legend for all Fire Alarm devices being installed.


10. Location of fire/smoke barrier walls on floor plans.

11. Identification of types of wire and cabling being used.

12. Sequence of operation for all devices.

13. Text of the pre-recorded audio messages capable of being broadcast over the evacuation system in addition to the chime tones.

14. Mounting details for all equipment and panels at or in excess of 20 lbs. Provide structural calculations, stamped by Structural Engineer, include in bid all costs.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All equipment shall be shipped in original packages to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturers’ recommendations. Provide protective covering during construction.

B. All equipment or material damaged during storage or installation shall be replaced at no expense to the Owner.

1.06 WARRANTY

A. The Contractor shall warrant all materials, equipment, apparatus, and workmanship to be free of defective materials and faulty workmanship for a period of one year from written notification of acceptance by Owner.

B. If repairs are necessary during the warranty period, the Contractor shall furnish all parts and labor to restore the
System to normal operation at no cost to the Owner.

C. The Contractor shall provide, upon notification of a problem, a qualified field service technician to correct the problem within 24 hours of notification.

1.07 SYSTEM DESCRIPTION

A. System Architecture:

1. Fire Alarm Control Panel is existing, references within alert the contractor to the programming requirements so that the new installation, connected to the existing will perform all Fire Alarm System functions described in these Specifications and shown on the Drawings. The FACP shall contain addressable device control boards, voice system amplifiers and controls, power supplies for visual signals and auxiliary devices, and related batteries, chargers, cabinets, etc. The FACP shall be part of the network for the California State University Monterey Bay Site. Provide all necessary wiring, connections, equipment hardware and software to accomplish this interface.

2. Furnish and install a remote annunciator, in a location approved by the State Fire Marshal, to display all alarms in the building.

3. Furnish and install new addressable devices, new audible signaling devices, and new visual signaling devices, in locations shown on the Drawings; connect all devices to the FACP.

4. Furnish all required wiring and conduit for connection of an owner-supplied central station transmitter to the FACP. The Contractor shall also provide a telephone connection (two RJ-31X jacks) and 120 VAC power to the transmitter at this location.

5. Furnish and install all required wiring and conduit for connection to a remote campus monitoring system. Send trouble and alarm signals to remote location via telephone lines.

B. System Performance and Operation:

1. Activation of any manual or automatic device shall:
   a. Annunciate at the FACP, the remote annunciator, and on the CBX Office annunciator. The system shall display an exact English language description of the specific device in alarm.
   b. Annunciate on the network system monitor and printer, located in the Engineering office, verify location with owner, via network digital communication.
   c. Sound an digitally-produced chime tone throughout the building via the fire alarm voice evacuation system. Following the tone, the system shall broadcast a pre-recorded evacuation or emergency message over the evacuation speakers.
   d. Activate all visual strobe alarm signals throughout the building.
   e. Release all magnetically held-open doors throughout the building.
   f. Send the appropriate signal to the UL-approved 24 hour central station via the transmitter adjacent to the FACP. The transmitter shall provide distinct signals for General Alarm, Water Flow Alarm, and System Trouble.
   g. Shut down all air handling units and this will close all smoke/fire dampers.
2. In addition to a) through g) above, the activation of a duct smoke detector shall close the associated smoke/fire dampers and shut down the associated fan or AC unit. Where required, the Fire Alarm system shall also send a signal to the B.M.S. to position system dampers into a fire mode (coordinate with Mechanical).

3. In addition to a) through g) above, the activation of an elevator lobby or elevator shaft smoke detector shall transmit a signal to the elevator controller to recall the elevators in the affected bank. A separate signal shall be provided for alternate floor recall.

4. In addition to a) through g) above, the activation of a smoke detector at a roll-up door or fire shutter shall close the associated smoke barrier.

5. In addition to a) through g) above, the activation of a sprinkler system flow switch shall sound a distinct audible alarm at the FACP.

6. In addition to a) through g) above, the activation of a sprinkler system supervisory device (tamper switch or PIV) shall sound a distinct audible alarm at the FACP and shall activate the system trouble relay.

7. All wiring or component failure shall annunciate at the FACP and activate the system trouble relay. Open or grounded circuits shall not cause sounding of false alarms. Portions of the system not affected by wiring derangements shall remain operational and capable of receiving alarms and performing specified operations.

PART 2 – PRODUCTS

2.01 Description

A. All panels and peripheral devices shall be the standard product of a single manufacturer. The catalog numbers specified under this Section are those of the Simplex Time Recorder Co. and constitute the type, product quality, and operating features required. Acceptable manufacturers are Simplex.

B. The existing Fire Alarm Control Panel (FACP) is a Simplex model 4100 U, complete with network communication board. The FACP shall support monitor and control devices on a two-way data communication wire loop. All devices shall be individually addressed, and shall be powered from the FACP. Provide control circuits and power supplies for all visual alarm signaling devices. All data, signal, and power circuits shall be supervised. The FACP shall be complete with cabinets, back boxes, power supplies, battery charger, and batteries rated for a minimum of 24 hours standby and 15 minutes of general alarm signal activation in the event of primary power interruption. The FACP shall be connected to a dedicated circuit, and have 100% battery back-up.

C. The FACP shall contain voice system controls, audio amplifiers, speaker circuits, speaker select switches, paging microphone, digital message generator, and all other components required for a fully operational voice communication system. In addition, the FACP shall contain multiple selectable audio tones (minimum 5) and digitally-created pre-recorded voice messages (minimum 10), local speaker for message/tone verification, and one back-up (standby) amplifier.

D. The FACP system software shall be stored in non-volatile memory. It shall be password-protected and capable of multiple levels of operator access. All system operations described herein shall be a function of the system software; they shall be fully field-programmable and editable. Changes in fire alarm programming shall be made only by certified factory-trained technicians. At no additional cost, include one complete additional reprogramming of the system after acceptance but prior to the end of the warranty period, for any changes that may be requested by the Owner.

E. The FACP shall have built-in capacity for future expansion. As part of this contract, include a minimum of eight internal, programmable relays. In addition, provide 20% spare capacity for the following:

1. Power supplies, battery back-up, and audio amplifiers.
2. Each data loop, for addition of addressable devices.

3. Each audio circuit, for addition of evacuation speakers.

4. Each signal circuit, for addition of strobe alarm signals.

5. Additional mounting space in the FACP cabinet.

F. Addressable Manual Stations shall be single-action type Simplex model 2099-9795 complete with trim ring. Mount at 48’ A.F.F. per ADA requirements.

G. Smoke Detectors shall be analog photoelectric type Simplex model 4098-9701 True Alarm sensors with addressable base model 4098-9781. Alarm sensitivity shall be adjustable from the FACP or the system Monitor/Keyboard.

H. Heat Detectors shall be analog type, Simplex model 4098-9731 True Alarm sensors with addressable base model 4098-9781. Alarm sensitivity shall be adjustable from the FACP or the system monitor/keyboard.

I. Duct Smoke Detectors shall be analog, photoelectric type Simplex model 4098-9701 True Alarm sensors with duct housing model 4098-9702. Alarm sensitivity shall be adjustable from the FACP or the system Monitor/Keyboard. Duct housing shall be complete with sampling tubes sized to duct width. Duct detectors shall be installed in weatherproof NEMA-3R enclosures in exposed locations.

J. Auxiliary interface modules shall be addressable type, Simplex model 2190-9155 (monitor) and model 21909163 (control). These shall be used to interface non-addressable devices or remote contact closures to the fire alarm system, or for programmed control functions (fan shutdown, damper closure, etc). Control modules shall contain two form “C” contacts rated at 2A.

K. Alarm Speakers/Strobe units shall be Simplex model 2902-9732, with 4903-9105 strobe and wall mount assembly 4903-9501. They shall meet ADA requirements for signal intensity, and shall be mounted at 90” AF.F. or 6” below the ceiling, whichever is lower, to comply with ADA requirements.

L. Alarm strobe lights shall be Simplex model 4904-9105 with wall mount assembly 4904-9501. They shall meet ADA requirements for signal intensity. Mount at 90” AF.F. or 6” below the ceiling, whichever is lower, to comply with ADA requirements. Do not exceed 10% maximum voltage drop on anyone circuit. Install circuits as required.

M. Provide lamacoid labels for all devices. Labels shall be epoxied onto device bases, and shall indicate device and circuit numbers. Devices located above ceilings, etc. shall have their locations marked with this same label and affixed to the ceiling tile, or access hatch to device.

N. Beam or Laser detectors. Complete with transmitter, receiver and custom mounting brackets and hardware for Atrium or open free air applications. Complete with detector interface module. Acceptable products shall be System Sensor BEAM 1224S or 6424, install complete with power supplies.

2.02 FIRE ALARM SYSTEM WIRING

A. All wiring shall conform to CEC Article 760 and to the manufacturer’s wiring specifications. Minimum sizes shall be as follows: data communication - #18 TSP solid copper; audio circuits - #16 TSP solid copper; signal circuits - #12 AWG solid copper. #14 wire may be used, however voltage drop with smaller gauge wire will require a greater number of signal circuits vs. #12.

B. All wiring shall be installed in dedicated Fire Alarm conduit (EMT); minimum acceptable size shall be 3/4”.

C. All wiring and conduit shall be concealed in walls or above finish ceilings, and shall be fastened and secured in proper and approved manner. Location of all wiring shall be indicated on the as-built drawings.
D. All wiring shall be Power Limited, Fire Protective Signaling Cable (type FPL), UL-Listed for the intended application.

PART 3 – EXECUTION

3.01 Installation

A. The Contractor shall install a complete, new Fire Alarm system, including all necessary equipment, raceway, and wiring, in compliance with all applicable Codes and Standards. All wiring shall be installed in dedicated Fire Alarm conduit (EMT); minimum acceptable size shall be 3/4".

B. The Contractor shall possess a current State of California C10 license.

C. The Contractor shall install all equipment and materials in accordance with the current recommendations of the Manufacturer. The installation shall be performed by technicians skilled in this type of work. All persons, installers and technicians involved in the installation of WIRE, CABLE, DEVICES, etc. shall be at a minimum NICET Level II Certified and shall possess certification. Submit with product submittals and shop drawings. Only those employees or technicians submitted shall be permitted to work on any or all phases of installation.

D. Work shall be installed in accordance with the following:
   1. Approved submittals.
   3. Applicable requirements of the referenced standards.
   4. Commonly accepted trade practices.

E. The supervision of installation and all required system software additions/changes shall be performed by factory-trained NICET Level II certified technicians.

3.02 Field Tests

A. The Contractor shall test all systems and devices and shall submit a report certifying that the installation is in full compliance with the contract documents. Testing of the system shall be performed with test instruments and procedures required by the Manufacturer, and in full compliance with NFPA guidelines. Any testing required to be performed on premium time shall be included as part of this Contract. Upon review of these documents by the Owner's Representative, acceptance tests shall be scheduled for all concerned parties.

   1. The test reports shall include the following:
      a. A complete list of all equipment installed.
      b. Certification by the Contractor and manufacturer's representative that all equipment is properly installed and functional and conforms with these Specifications.
      c. Certification by Contractor of tests of all individual zones and devices have been tested for proper alarm, annunciation, control, and supervision.
      d. Technician's name, company, and date of test.

B. The Contractor shall provide equipment for air flow differential testing, and shall perform same to verify proper duct detector location and operation.

C. Upon review of the test results described in 3.02A above by the Owner's representative, the Contractor shall
perform a full system test in the presence of the Owner's representative. Upon satisfactory completion of this test and the resolution of the subsequent punch list items, the final acceptance test shall be scheduled as described below.

D. Upon satisfactory completion testing described in A.) through C.) above, the final acceptance test shall be scheduled (minimum 72 hours notice) and performed in the presence of the Local Fire Marshal, Architect, and the Owner's Representative. The final acceptance test shall include a complete test of all system devices and functions, and any additional testing requested by the Local Fire Marshal. The Contractor shall provide all personnel and equipment necessary to accomplish the test.

E. Upon successful completion of testing, the Contractor shall present the Owner with a completed-cop y of NFPA Fire Alarm System Certification and Description form (referenced in NFPA 72), signed by the Contractor and the State Fire Marshal, signifying system completion and acceptance.

3.03 Training

A. The Contractor shall provide a minimum of six copies of Operation and Maintenance manuals (in indexed, three-ring binders) for all equipment furnished under this Section:

1. Manuals shall provide the name and phone number (24 hour) of the person to be called in the event of equipment failure.

2. Manuals shall contain manufacturers' data sheets and Wiring diagrams for all products furnished and installed under this Contract.

3. Detailed instructions shall be included to permit troubleshooting, diagnosis, and repair to the circuit board replacement level for all systems.

4. Detailed instructions shall be included regarding recommended preventative maintenance and testing procedures, including software instructions for generating smoke detector status reports.

B. As a part of this contract, the Contractor shall provide training for the California State University Monterey Bay Engineering staff, Security officers, Telecommunications personnel, and all other personnel (including local Fire Department representatives) required to operate or respond to the Fire Alarm system. Training shall be conducted by engineers or technicians highly skilled in the systems, and certified by the manufacturer as qualified to train in the particular systems. A video tape of basic system features and operations shall be provided as reference material.

C. The Contractor shall provide a minimum of 40 hours of training for systems furnished under this contract. Training shall be conducted at dates and times agreed upon by the Contractor and the Owner.

D. Training for the California State University Monterey Bay Engineering staff shall include instruction on system operation (e.g. changing zone labels, disabling system points, etc.) It shall also include maintenance-related functions such as querying the system for smoke detector obscuration levels, and adjusting detector sensitivities. This instruction shall be performed in multiple sessions to allow the staff time to operate and familiarize themselves with system operation before returning for follow-up instruction.

3.04 System Acceptance

A. Acceptance shall consist of the following:

1. Burn-in period.

   a. The system shall be accepted for start of warranty upon successful completion and testing of AHJ and Consultant.

   b. Burn-In period shall be a 30 day time frame to allow the system to operate free of
defects, grounds, programming faults, etc.

c. The 30-day Burn-In shall begin the day of acceptance by AHJ.

d. The Burn-In period shall be 30 days of continuous use without system trouble, false alarm, open, short or ground condition present.

e. Should the system fail for any reason during the burn-in period, the contractor shall respond immediately upon notification by Client personnel and correct said deficiencies.

f. Upon correction and restoration, the "Burn-In" period shall be re-set to "0" and the 30 day count shall begin again.

g. Warranty shall commence upon day 31 of successful "Burn-In" period.

B. Prior to release of retention compensation, the Owner shall require receipt of the following items:

1. A completed copy of NFPA Fire Alarm System Certification and Description form signed by the Contractor and the State Fire Marshal.

2. Verification of completion of training as described in Section 3.03 above.

3. Operation and Maintenance manuals as described in Section 3.03.A. above.

4. A statement of warranty including date of termination.

5. Complete set of record as-built drawings, indicating location of devices, wiring, and conduits, and showing all interconnect wiring details. The Contractor shall provide one set of blue line sets.

6. Copy of the test reports described in paragraph 3.02.A. above.

END OF SECTION
SECTION 16725

TELECOMMUNICATIONS CABLE

PART 1 – GENERAL

1.01 Section Includes:

A. Interbuilding Copper Cable
B. Copper Riser Cable
C. Copper Station Cable
D. Interbuilding Fiber Optic Cable
E. Fiber Optic Riser Cable
F. Fiber Optic Station Cable
G. Coaxial Riser Cable
H. Coaxial Station Cable
I. Headend and Distribution Cable Interface

1.02 Related Sections

A. Contract Terms and Conditions
B. Section 16710 - Telecommunications General Requirements
C. Section 16715 - Acceptance Testing
D. Section 16720 - Basic Materials and Methods
E. Section 16730 - Underground Structures - Telecommunications
F. Section 16760 - Telecommunications Grounding and Bonding

1.03 Applicable Publications

A. As defined in Section 16710 - Telecommunications General Requirements.

1.04 Submittals

A. The Contractor shall submit the following materials to the Owner’s representative prior to the placement of cable:

B. Product data, including both product construction and performance specifications, for each type and configuration of cable to be supplied. In addition, the Contractor shall provide product data and installation instructions for all fire stopping materials.

C. Proof of Structured Cabling System certification.
D. Copies of signed optical cable reel tests.

PART 2 – MATERIALS

A. The products listed in this section represent the standards for materials, workmanship, and performance for the University’s telecommunications infrastructure installation. All materials in this section shall be manufactured and warranted by the Structured Cabling Solution manufacturer.

2.02 Interbuilding Copper Cable

A. Material

1. Application: Use for outside conduit and direct buried applications.

2. Compliance: REA Specification PE-39 or Telcordia GR-421-CORE.

3. Core Construction

   a. Conductors: Solid, annealed copper, 24 AWG on cable runs up to 2500 feet, and 22AWG for cable runs 2500 feet or longer.

   b. Insulation: Solid, high-density polyethylene or filled foam skin ASP, color-coded in accordance with telephone industry standards.

   c. Twisted Pairs: Insulated conductors twisted into pairs with varying lay lengths to minimize crosstalk. Standard capacitance of 83 to 87 nanofarads per mile and a staggered twist design.

   d. Core Assembly: Cables of 25 pairs and less formed by assembling pairs together in a single group. Cables of more than 25 pairs formed by twisted pairs arranged in groups with each group having a color coded unit binder.

   e. Filling Compound: Core assembly completely filled with ETPR compound, filling the interstices between the pairs and under the core tape.

   f. Core Wrap: Non-hygroscopic dielectric tape applied longitudinally with an overlap.

4. Shielding

   a. Dual shield sheath system:

      Inner layer: A corrugated, copolymer coated, 8-mil aluminum tape applied longitudinally without butting or overlapping.

      Outer layer: A corrugated copolymer coated, 6-mil steel tape applied over the aluminum and overlapped. The sheath interfaces are flooded with an adhesive water-blocking compound to provide a moisture barrier and inhibit corrosion.

5. Cable sizes defined in design documents.

B. Manufacturer: Manufacturer shall meet requirements of selected Structured Cabling System.

2.03 Copper Riser Cable

A. Material

1. Application: Use for placement in vertical risers in buildings and in general horizontal applications within buildings.


3. Core Construction

   a. Conductors: Solid annealed bare copper conductors, 24 AWG.

   b. Insulation: Dual insulation consisting of an inner layer of foamed polyolefin surrounded by a solid PVC skin, color-coded in accordance with telephone industry standards.

   c. Twisted Pairs: Insulated conductors twisted into pairs with varying lay lengths to minimize crosstalk.

   d. Core Assembly: Cable cores made up of 100 pair super-units consisting of four (4) 25 pair sub-units. Each group individually identifiable by color-coded unit binders. Each 25 pair-unit within the 100 pair super-unit identified with a different binder color. (Note: “PIC MIRROR IMAGE” multi-unit identification used in cables over 900 pairs.)

   e. Core Wrap: Non-hygroscopic dielectric tape applied longitudinally with an overlap.

4. Alvyn Sheath

   a. Aluminum Shield: Corrugated, adhesive coated, 0.008” aluminum tape applied longitudinally with an overlap.

   b. Jacket: Gray, flame retardant PVC jacket bonded to the coated aluminum.
2.04 Copper Station Cable

A. Material

1. Application: Use for voice and data applications to interconnect services from workstation to the wiring closet in a plenum or non-plenum rated space.


3. Make up: Four unshielded twisted pair, 24 AWG, solid annealed bare copper conductors insulated with FEP and covered with a flame retardant PVC jacket.

4. All copper station cable shall be Category 6, Plenum rated with the following transmission characteristics:

   a. DC Resistance: The resistance of any conductor shall not exceed 9 ohms per 100 m (328 ft) at or corrected to a temperature of 20°C.

   b. DC Resistance Unbalance: The resistance unbalance between the two conductors of any pair shall not exceed 3% when measured at or corrected to a temperature of 20°C.

   c. Capacitance: The capacitance of any pair at 1 kHz and measured at or corrected to a temperature of 20°C shall be 15pf/ft.

   d. Input Impedance: The cable shall have typical input impedance values based on swept frequency cable input measurements only. Curve fitting or smoothing functions will not be accepted.

      | Frequency (MHz) | Impedance (Ohms) |
      |---------------|------------------|
      | 1.0 – 20.0    | 100 +/- 12      |
      | 2.0 – 200.0   | 100 +/- 15      |
      | 200.0 – 310.0 | 100 +/- 20      |
      | 310.0 – 350.0 | 100 +/- 22      |

   e. Return Loss (RL): The RL values shall be based on swept frequency cable input measurements only. The RL value of the cable shall be a minimum of 20dB over the Category 6 Standard at 250Mhz.

   f. Attenuation: The attenuation is derived from swept frequency signal level measurements at the output of cable lengths greater than or equal to 100 m (328 ft). The maximum attenuation of any pair, in dB per 100 m, measured at or corrected to a temperature of 20°C shall be less than or equal to 31.30db at 250Mhz.

   g. Near End Crosstalk (NEXT): NEXT loss is derived from swept frequency measurements using a network analyzer. The minimum NEXT loss for any pair combination shall be at least 4dB over the Category 6 Standard at 250Mhz.

   h. Power-Sum Near End Crosstalk (PSNEXT): PSNEXT loss is derived from swept frequency measurements using a network analyzer and an s-parameter test set. The minimum PSNEXT loss for any pair combination at room temperature shall be at least 4dB over the Category 6 Standard at 250Mhz.
i. Power Sum Equal Level Far End Crosstalk (PSELFEXT): PSELFEXT loss is derived from swept frequency measurements using a network analyzer and an s-parameter test set. The minimum PSELFEXT loss for any pair combination at room temperature shall be 4dB over the Category 6 Standard at 250Mhz.

j. Propagation Delay: The propagation delay of any pair at 10 MHz shall not exceed 510ns/100m.

k. Propagation Delay Skew: The propagation delay skew between any two pairs shall not exceed 18 ns/100m at 10 MHz.

l. Attenuation to Crosstalk Ratio (ACR): ACR shall be 4dB over the Category 6 Standard at 250Mhz.

m. Powersum Attenuation to Crosstalk Ratio (PSACR): PSACR shall be 4dB over the Category 6 Standard at 250Mhz.

5. Station cables shall have a color jacket as follows:
   a. White – Analog/Digital Voice
   b. Yellow – Data 1
   c. Green – Data 2

B. Manufacturer: Manufacturer shall meet requirements of selected Structured Cabling System.

C. Interbuilding Fiber Optic Cable – Multi-mode

D. Materials

1. Application: Indoor/Outdoor fire retardant OFNR, UV-stabilized, fully water blocked, used for placement in outside plant conduit between buildings without requiring a transition splice once entering the building.

2. Compliance: Meet or exceed ANSI/EIA/TIA-492 AAAA specifications, UL-1666, Telcordia GR-2961-CORE, and characteristics listed below.

3. Characteristics
   a. Fully water blocked (wrapped in water swellable yarn)
   b. Dielectric
   c. Loose buffer tube construction
   d. For Laser Optimized 50/125 µm
   e. 50/125 µm (core/cladding) dual window (850 and 1300 nanometers)
   f. Laser Optimized for 10Gbase-SX at 850 nanometers to 300 meters.
   g. Maximum attenuation: 3.50 dB/km @ 850 nm and 1.0 dB/km @ 1300 nm
   h. Minimum bandwidth: 1500 MHz/km @ 850 and 500 MHz/km @ 1300 nm
   i. .260 numerical aperture
j. For Standard 62.5/125 µm

k. 62.5/125 µm (core/cladding) dual window

l. Maximum attenuation: 3.5 dB/km @ 850 nm and 1.0 dB/km @1300 nm

m. Minimum bandwidth: 200 MHz/km @ 850 nm and 500 MHz/km @ 1300 nm

n. Minimum pulling tension of 600 lbs.

o. Equipped with a breakout, furcation, or blocking kit to dress the end of the cable and eliminate the flow of fill compound

E. Manufacturer: Manufacturer shall meet requirements of selected Structured Cabling System.

2.05 Interbuilding Fiber Optic Cable – Single-mode

A. Materials

1. Application: Indoor/Outdoor fire retardant OFNR, UV-stabilized, fully water blocked, used for placement in outside plant conduit between buildings.

2. Compliance: Meet or exceed ANSI/EIA/TIA-492 AAAA specifications, UL-1666, Telcordia GR-2961-CORE, and characteristics listed below.

3. Characteristics:

   a. Fully water blocked (wrapped in water swellable yarn)

   b. Dielectric

   c. Loose buffer construction

   d. 8.3/125/250 µm (core/cladding/protective coating) dual window (1300 and 1550 nanometers)

   e. Maximum attenuation: .4 dB/km @ 1310 nm and .3 dB/km @ 1550 nm

   f. Maximum dispersion (1285 to 1330 nanometers): 3.5 ps/(nm/km)

   g. Zero dispersion slope (1300 - 1322 nm): -0.095/(nm²/km)

   h. Minimum pulling tension of 600 lbs

   i. Equipped with a breakout, furcation, or blocking kit to dress the end of the cable and eliminate the flow of fill compound
2.06 Fiber Optic Riser Rated Cable – Multi-mode

A. Materials

1. Application: Use for placement in vertical riser backbone within buildings.

2. Compliance: Meet or exceed ANSI/ICEA S-83-596 per requirements of ANSI/TIA/EIA-568 B, UL 1666, Telcordia GR-2961-CORE specifications and characteristics listed below.

3. Characteristics

   a. OFNR/FT4 rated for riser applications
   b. Dielectric strength member
   c. Tight buffer design
   d. 50/125 µm (core/cladding) dual window (850 and 1300 nanometers)
   e. Laser Optimized for 10Gbase-SX at 850 nanometers to 150 meters.
   f. Maximum attenuation: 3.5 dB/km @ 850 nm and 1.5 dB/km @ 1300 nm
   g. Minimum bandwidth: 200 MHz/km @ 850 and 500 MHz/km @ 1300 nm
   h. .275 numerical aperture
   i. Minimum pulling tension of 600 lbs.
   j. Equipped with a breakout, furcation, or blocking kit to dress the end of the cable and eliminate the flow of fill compound
   k. Interlocking armored with flame-retardant inner and outer jacketing

B. Manufacturer: Manufacturer shall be the selected Structured Cabling System Solution manufacturer.

2.07 Fiber Optic Riser Rated Cable – Single-mode

A. Materials

1. Application: Use for placement in vertical riser backbone within buildings. OFNR type fiber cable.

2. Compliance: Meet or exceed ANSI/ICEA S-83-596 per requirements of ANSI/TIA/EIA-568 B, UL 1666, Telcordia GR-2961-CORE specifications and characteristics listed below.

3. Characteristics

   a. OFNR/FT4 rated for riser applications
   b. Dielectric strength member
   c. Tight buffer design
   d. Fiber diameter to be 8.3/125/250 µm (core/cladding/protective coating) dual window (1300 and 1550 nanometers)
e. Maximum attenuation: .4 dB/km @ 1310 nm and .3 dB/km @ 1550 nm
f. Maximum dispersion (1285 to 1330 nanometers): 3.5 ps/(nm/km)
g. Zero dispersion slope (1300 - 1322 nm): -0.095/(nm²/km)
h. Minimum pulling tension of 600 lbs.
i. Equipped with a breakout, furcation, or blocking kit to dress the end of the cable and eliminate the flow of fill compound
j. Interlocking armored with flame-retardant inner and outer jacketing

B. Manufacturer: Manufacturer shall be the selected Structured Cabling System Solution manufacturer.

2.08 Fiber Optic Riser Cable – Composite

A. Materials

1. Application: Use for placement in vertical riser backbone within buildings.

2. Compliance: Meet or exceed ANSI/ICEA S-83-596 per requirements of ANSI/TIA/EIA-568 B specifications, UL 1666, Telcordia GR-2961-CORE specifications and characteristics listed below.

3. Interlocking armored with flame-retardant inner and outer jacketing

4. Characteristics - Cable

a. OFNR/FT4 rated for riser applications
b. Dielectric strength member
c. Tight buffer design
d. Minimum pulling tension of 600 lbs.

5. Characteristics - Multimode

a. 50/125 µm (core/cladding) dual window (850 and 1300 nanometers)
b. Laser Optimized for 10Gbase-SX at 850 nanometers to 150 meters.
c. Maximum attenuation: 3.50 dB/km @ 850 nm and 1.5 dB/km @ 1300 nm
d. Minimum bandwidth: 950 MHz/km @ 850 and 500 MHz/km @ 1300 nm
e. .275 numerical aperture

6. Characteristics - Single mode

a. 8.3/125/250 µm (core/cladding/protective coating) dual window (1300 and 1550 nanometers)
b. Maximum attenuation: .4 dB/km @ 1310 nm and .3 dB/km @ 1550 nm
c. Maximum dispersion (1285 to 1330 nanometers): 3.5 ps/(nm/km)
d. Zero dispersion slope (1300 - 1322 nm): -0.095/(nm²/km)
B. **Manufacturer:** Manufacturer shall be the selected Structured Cabling System Solution manufacturer.

2.09 Fiber Optic Station Cable – Multi-mode

A. **Materials**

1. **Application:** Use for placement in fiber to the workstation within a building. Horizontal run from telephone closet to information outlets.

2. **Compliance:** Meet or exceed ANSI X3T9.5 PMD, UL 910 OFNP, Telcordia GR-409-CORE, TIA/EIA 568–A, Gigabit Ethernet, specifications and characteristics listed below.

3. **Characteristics**

   a. Plenum Rated OFNP/FT6

   b. Dual optic, multimode cable intended for use with transmission rates up to and including 155 Mbps in a network with ATM standards

   c. 62.5/125 µm (core/cladding) dual window (850 and 1300 nanometers)

   d. Maximum attenuation: 3.4 dB/km @ 850 nm and 1.0 dB/km @ 1300 nm

   e. Minimum bandwidth: 200 MHz/km @ 850 and 500 MHz/km @ 1300 nm

   f. .275 numerical aperture

   g. Strippable jacket and either a central strength member or high tensile strength yarn for mechanical protection

   h. Tension rating of 200 pounds or greater

B. **Manufacturer:** Manufacturer shall be the selected Structured Cabling System manufacturer.

2.10 Fiber Optic Station Cable – Single-mode

A. **Materials**

1. **Application:** Use for placement in fiber to the workstation within building a building.

2. **Compliance:** Meet or exceed ANSI X3T9.5 PMD specifications and characteristics listed below.

3. **Characteristics**

   a. Plenum Rated OFNP/FT6

   b. Dual optic, multimode cable intended for use with transmission rates up to and including 155 Mbps in a network with ATM standards

   c. 9/125/250 µm (core/cladding/protective coating) dual window (1300 and 1550 nanometers)

   d. Maximum attenuation: .4 dB/km @ 1310 nm and .3 dB/km @ 1550 nm

   e. Maximum dispersion (1285 to 1330 nanometers): 3.5 ps/(nm/km)

   f. Zero dispersion slope (1300 - 1322 nm): -0.095/(nm2/km)
g. Strippable jacket and either a central strength member or high tensile strength yarn for mechanical protection

h. Tension rating of 200 pounds or greater

B. Manufacturer: Manufacturer shall be the selected Structured Cabling System Solution manufacturer.

2.11 Coaxial Station Cables

A. Distribution Cables

1. Application: Use for placement between IDF's on same floors and to distribute the Building CATV System signals.

2. Compliance: Meet or exceed NEC specifications and characteristics listed below.

3. Characteristics

   a. 500-coaxial cable, plenum-rated (CATVP).

   b. Foamed Teflon dielectric cable.

   c. Support frequencies between 5 - 1000 MHz.

   d. Nominal attenuation not to exceed 4.31dB per 100 feet at 1000 MHz.

   e. Capacitance 16.4 pF/ft ± .5 pF/ft.

   f. Impedance 75 ohms ± 3 Ohms.

4. Manufacturer: Manufacturer shall be the selected Structured Cabling System Solution manufacturer.

B. Distribution Cable Connectors

1. The pin type connectors for the .500 distribution cable shall be designed to mate with the various active and passive components in the riser and plenum components of the Building CATV System.

2. Only a connector recommended by the cable manufacturer shall be installed.


2.12 Coaxial Riser Cables

A. See Section 16740

2.13 Coaxial Station Cables

A. See Section 16740

PART 3 – EXECUTION

3.01 General Installation

A. All installation work shall be performed according to published industry guidelines, rules, and regulations. If disputes occur, local, state, and national codes have precedence; then CSUMB polices and procedures; then standards such as EIA/TIA; then guidelines from firms such as Building Industry Consulting Services International
B. The Contractor shall provide sufficient trained staff to monitor all work undertaken and ensure that the requirements of these specifications are met throughout the installation process.

C. All tests will be conducted using equipment that has had Laboratory or manufacturer certified calibration within the previous six months of the tests. The Contractor shall provide a signed copy of the calibration test results for each item of test equipment with the acceptance documentation.

D. All installation work will be of the highest quality. The Contractor shall at all times make every effort to conduct all installation work in a manner so as to minimize the impact on the facilities. Whenever possible, all work will be hidden behind finished materials and all surfaces will be returned to their original condition.

E. The Contractor shall provide and install all pathway and cable support hardware necessary to successfully complete the installation. This includes, but is not limited to, hangers, ladder racks, support brackets, conduit and sleeves, fire stop materials, tie-wraps, and access openings such as core drills.

F. The Contractor shall ensure that only staff fully qualified to work on specific types of materials are allowed to undertake the required installation. Particularly, copper and fiber optic cable placement, termination, splicing, and testing shall only be undertaken by staff certified by the Structured Cabling System manufacturer.

G. The Contractor shall provide all hardware, software, and miscellaneous components necessary to provide a complete system.

3.02 Interbuilding Copper Cable

A. The interbuilding cables shall be installed by certified personnel according to the selected Structured Cabling System manufacturer's procedures.

B. Cables shall be routed in such a manner as to allow other maintenance activities to occur without damage to the cable. All cables in vaults shall be routed as close to walls as possible to reduce accidental damage. Cable routed through manholes shall be attached to the cable rack supports using "L" cable rack supports.

C. All cable runs installed in conduit or duct banks shall include a nylon pull cord (1/4 inch), tied off at each end of run, unless the conduit is full. The University Representative will determine whether a conduit is too full for the addition of a pull cord. A nylon or polyethylene pulling line shall be used in all fiber optics raceways. The pull cord shall be clearly labeled as "pulling line," indicating source and destination.

D. Placement of cable in individual conduits shall be determined by the Contractor and the Owner's representative to ensure the best utilization of the distribution space. All conduits shall be pulled as full as possible without damage to the cable. All cables shall be secured to the wall of the BDFs, vaults, manholes, pull boxes, etc. using "L" cable rack supports.

E. All cables shall be clearly labeled according to campus labeling standards specified in Exhibit 16720-B “Label Grammar” with cable number and count and size at each end of the cable (including the beginning and end of service loops), when it enters or leaves a conduit, and at 30 foot intervals when run in accessible areas such as tunnels, manholes, ceilings, etc.

F. All cables shall be placed using swivel-pulling eyes to reduce cable coils.

G. All cables shall be routed with wide sweeps without bends or kinks in the cable or sheath. The minimum bending radius for all cable is sixteen (16) times the cable diameter or manufacturer's specifications, whichever is greater.

H. Cuts and abrasions that penetrate the outer sheath of the cable shall be inspected by the Contractor and the Owner's representative to determine if the cable shall be replaced or may be patched. Decisions regarding the
suitability of cables damaged during placement will be the responsibility of the Contractor and the Owner’s representative and shall be expressed in writing by the Contractor.

I. All cable shields shall be bonded end-to-end and grounded per TIA/ATIS JSTD-607A requirements for telecommunications grounding and bonding. NEC article 800 part D grounding methods.

J. When entering a building filled cables shall be spliced into shielded protector tails. Cable splices shall be attached to walls using "B" cable rack and "L" cable rack supports. Splices shall be properly secured to the "L" support preventing detachment by external forces. Splice cases shall be dressed and mounted to eliminate the movement of gel compound.

K. Entrance Cables

1. To prevent shear, all conduit entering a building shall transition from PVC to metal or shall be contained in a metal sleeve from a distance of 24 inches beyond the exterior of the foundation to six inches within the building. These conduits shall slope downward away from the building to reduce the potential of water entering the building. Spare Maxcell inner duct will be placed to fill the conduit to ensure maximum utilization of the conduit where noted on contract drawings.

   a. A separate conduit shall be used for each type of media. Copper entrance cables shall be placed one conduit, Maxcell inner ducts and fiber cables placed in a separate conduit, and coax placed in a separate conduit.

   b. Outside Plant Filled Copper and Fiber Cables shall not penetrate more than 50 feet (except in metallic conduit) before a conversion splice is made to fire resistant type cable. (ARMM for copper and OFNP for fiber).

   c. Filled cable shall not be terminated on 110-hardware without a transition splice to fire resistant type cable (ARMM) or tip cables.

   d. All entrance cables and protectors shall be grounded per TIA/ATIS JSTD-607A requirements for telecommunications grounding and bonding and. NEC article 800 part D.
L. All installed empty conduits shall be plugged with a neoprene or rubber duct plug to prevent water and/or gas seepage into a building or manhole. Conduit containing cable will be filled with the appropriate compound.

3.03 Copper Riser Cable

A. All riser cables shall be installed in a neat and orderly manner that provides the maximum amount of room for future cable additions. All riser conduits shall be pulled as full as possible, up to the 40% fill ratio. All cables shall be supported on each floor using at least three straps (not more than 30 inches apart) per floor. Riser cable shields shall be grounded on any floor in which pairs enter or leave the sheath. All shields shall be bonded end-to-end.

B. All riser conduits shall be sealed using a UL classified fire stop. The Contractor shall provide a copy of the fire seal manufacturer’s installation instructions and rating information prior to inspection of the installed materials. See specification SECTION # 07840 for fire stopping methods and systems.

C. All riser cables and conduits shall be labeled in accordance with Exhibit 16720-B “Label Grammar.”

3.04 Copper Station Cable

A. All station cables shall be neatly dressed, secured, and concealed throughout the installation. Cables shall be secured with plastic ties or hook and loop type straps (Velcro™) to a snug fit but shall not deform the cable geometry. Ties shall be of a plenum-rated material if cable is installed within a plenum ceiling space.

B. All station cables shall be secured a minimum of six (6) inches above the ceiling T-bar grid. Ceiling grid supports, electrical conduit, water pipes, and HVAC ducting may not be used to support cables. In those areas without adequate support structures, the Contractor shall install “J” hooks or additional ceiling grid hangers on five-foot centers. No more than 12 individual cables will be secured to a single ceiling hanger without the use of a two-inch wide saddle to eliminate strain on individual cables. Cables shall not be placed within 24 inches of overhead lights or any other potential source of electrical interference.

C. In any area in which a fire-rated wall, partition, floor, or ceiling is penetrated, the Contractor shall be responsible for creating the pathway and sealing around all cables and sleeves with a UL classified fire seal sufficient to return the structure to its original rating. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the Contractor. Any opening in a rated structure created by the Contractor that is larger than one inch in diameter shall be equipped with a metal sleeve secured and fire-stopped in place.

D. In station locations with walls that shall be fished, the Contractor shall place a plaster wall retaining ring or metal supporting “ears” around the outlet location to secure the outlet and faceplate. No exposed cable shall be permitted.

E. In locations where the wall cannot be fished and surface-mount raceways are utilized, all raceways shall be mechanically secured to the structure a minimum of every four feet, shall be routed at right angles to nearby structures or wall corners, and shall be neatly installed and trimmed to fit into and around other existing moldings or pathways such as the ceiling area. Raceways shall be placed vertically only in corners of rooms and horizontal raceway placed at baseboard height to extend the cable run to the actual outlet location. In open ceiling areas where station cable are placed in surface mounted raceways a 1” trade size conduit shall be extended from top end of raceway to cable tray.

F. All station cables shall be placed with a 1 meter maintenance loop (slack cable) neatly coiled and secured in the ceiling space above the BDF and IDF terminals to allow for future rearrangement.

G. The Contractor is responsible for removing, replacing, and repairing ceiling tiles in order to route all cables. Concealed spline ceiling tiles shall not be replaced until installation work in that area has been inspected and reviewed with campus personnel and approval given to re-fix the ceiling in place.
H. Voice station cables shall be terminated on insulated displacement hardware (e.g., 110 connector blocks) and shall be clearly marked with a unique identification number in compliance with Exhibit 16720-B “Label Grammar.”

I. Data and network station cable shall be terminated on data network patch panels and shall be clearly marked with a unique identification number in compliance with Exhibit 16720-B “Label Grammar.”

3.05 Interbuilding Fiber Optic Cable

A. All fiber cable will be pre-tested by the manufacturer, before shipping, to guarantee there are no defective fibers. These cables shall be re-tested, on the reels, before installation to ensure no damage occurred during shipping.

B. No splices shall be made in the installed fiber optic cable except where noted on construction prints. Any other splice shall have the agreement in writing of the owner’s representative. Any splices allowed shall be fusion splices, and splice loss shall not exceed .2dB at 1300 nm.

C. Any pigtails used shall be tight-buffered Kevlar, and splice loss shall not exceed .2dB at 1300 nm.

D. All fiber optic cable maintenance loops shall be coiled and securely mounted to the wall in a manner that will prevent physical damage. Location of the coil shall be confirmed with owner’s representative.

E. All cables (and panels) shall be clearly identified. All labels will be securely attached to each end of the cable whenever it enters or leaves a conduit and at 30-foot intervals when run in accessible areas such as tunnels, manholes, ceilings, etc. Labels shall use the university’s approved cable/optic numbering system as specified in Exhibit 16720-B “Label Grammar.”

F. Interbuilding fiber optic cable shall be placed within inner duct unless otherwise noted.

G. Since fiber optic pigtails are recommended, the terminating patch panels shall provide adequate enclosed splice trays to secure the splices.

H. The contractor shall ensure proper placement and pulling techniques are employed throughout the installation and testing of this cable. Breakaway swivel grips shall be used to reduce coiling of cable during the pull and to limit the potential of exceeding the stated pulling tension. Any observed bending of fiber cable during and after the installation that exceeds the manufacturer’s recommended bending radius shall be cause for complete replacement of that cable by the contractor.

I. All fiber shall be terminated in a patch panel with SC style connectors. All fiber terminations and shall be properly secured and protected from mechanical damage. The use of pre-terminated connectors utilizing an index matching gel for the interface between the cleaved fiber end and the captive fiber are not permitted. Fibers intended for broadband video or CATV use, as otherwise identified on the plans, shall be connectorized by fusion splicing of factory terminated SC-APC pigtails onto the bare fiber ends.

J. Coils of slack cable shall be provided in each fiber termination unit (patch panel) prior to terminating the cable on connectors. The amount of cable should comply with the manufacturer’s requirements that are specified for the fiber termination unit.

K. At least 5 meters of cable (maintenance loop) neatly coiled and secured to the wall is required at each end of the fiber optic run. Location of the maintenance loop shall be confirmed with owner’s representative.

3.06 Fiber Optic Riser Cable

A. The fiber riser and horizontal tie cables shall be placed in a star configuration, as defined in the drawings, and shall be continuous (no splices) end-to-end.

B. A total of six feet of slack (in each equipment room) shall be provided for each cable, and the slack shall be coiled
and secured to the wall. Location of the maintenance loop shall be confirmed with Owner’s representative.

C. All cables (and panels) shall be clearly identified at both ends with a unique cable/optic numbering system. The number system shall be in compliance with Exhibit 16720-B “Label Grammar.”

D. All cables shall be installed using the selected Structured Cabling System manufacturer’s procedures, tools, and equipment and shall be protected from physical damage. All fiber cables shall be installed so as to protect the optical fibers and connectors from strain and physical damage. The minimum-bending radius shall not be exceeded during cable placement.

E. All riser cables shall be supported with strain relief on each floor.

3.07 Fiber Optic Station Cable

A. All fiber cable will be pre-tested by the manufacturer, before shipping, to guarantee there are no defective fibers. These cables should be re-tested, on the reels, before installation to assure no damage occurred during shipping.

B. No splices shall be made in the installed fiber optic station cable.

C. All fiber optic cable shall be coiled and secured in a manner that will prevent physical damage.

D. All cables (and panels) shall be clearly identified at both ends with a unique cable/optic numbering system in compliance with Exhibit 16720-B “Label Grammar.”

E. All cables shall be installed using the selected Structured Cabling System manufacturer’s standard procedures, tools, and equipment and shall be protected from physical damage. All fiber cables shall be installed so as to protect the optical fibers and connectors from strain and physical damage. The minimum bend radius shall not be exceeded during cable placement.

3.08 Coaxial Riser Cable

A. The Contractor shall install the coaxial riser cables within a single 4" conduit in the riser pathway (sleeves only).

B. All cables, devices, and equipment shall be clearly identified as specified in Exhibit 16720-B “Label Grammar.

C. All cables shall be installed using published industry standard procedures, tools, and equipment and shall be protected from physical damage. The minimum bend radius shall not be exceeded during cable placement.

D. Proper connect tools shall be utilized. “Quick connect” connectors will not be allowed.

3.09 Coaxial Station Cable

A. The Contractor shall install the coaxial station cables within a single 4" conduit in the riser pathway (sleeves only).

B. All cables and outlets shall be clearly identified as specified in Exhibit 16720-B “Label Grammar.”

C. All cables shall be installed using published industry standard procedures, tools, and equipment and shall be protected from physical damage. The minimum-bending radius shall not be exceeded during cable placement.

D. Proper connect tools shall be utilized. “Quick connect” connectors will not be allowed.

E. A maintenance coil of three additional feet of station cable shall be secured in the ceiling space above or near the outlet.

END OF SECTION
SECTION 16730
UNDERGROUND STRUCTURES – TELECOMMUNICATIONS

PART 1 - GENERAL

1.01 Section Includes:
   A. Publications and Standards
   B. Vaults
   C. Handholes
   D. Vault/Handhole Hardware
   E. Duct Banks
   F. Entrance Conduit
   G. Locating Duct Bank Cable
   H. Pull Rope
   I. Bonding/Grounding
   J. Conduit and Raceway Tags

1.02 Publications and Standards
   A. National Electrical Code (NEC) (ANSI/NFPA 70):
      1. Chapter 8: “Communications Systems”
      2. Article 250: “Grounding”
   C. Federal Communications Commission (FCC) Part 15 and Part 68
   D. Rural Utilities Services (RUS), formally REA
   E. Lightning Protection Code - ANSI/NFPA 780
   F. American Society for Testing Materials (ASTM) Publications
   G. National Electrical Manufacturer's Association (NEMA) Publications
J. Underwriter’s Laboratories Inc. (U.L.) Publications
   1. 6-1981 (R86) Rigid Metallic Conduit
   2. 514B-1982 Fittings for Conduit and outlet Boxes
   3. 651-1981 Schedule 40 and 80 Rigid PVC Conduit
   4. UL 467 “Grounding and Bonding Equipment”
   5. UL 497,497A, and 497B “Communications Circuit Protectors”

K. California State University, Office of the Chancellor - Telecommunications Infrastructure Planning (TIP) Guidelines - 1999

1.03 Related Sections
   A. Contract Terms and Conditions
   B. Section 16710 - Telecommunications General Requirements
   C. Section 16715 - Telecommunications Acceptance Testing
   D. Section 16720 - Telecommunications Basic Materials and Methods
   E. Section 16725 - Telecommunications Cable
   F. Section 16740 – Campus CATV System
   G. Section 16760 - Telecommunications Bonding and Grounding

1.04 Submittals
   A. Submittals shall be made as defined in Section 16710.

1.05 Quality Assurance
   A. For products or workmanship specified by association, trade, Federal, or State Standards, the Contractor shall comply with the requirements of the standard. When more rigid requirements are specified or required by applicable (City) codes, the Contractor shall comply with City codes.
   B. The Contractor shall conform to reference standard by date of issue current on final design documents.

PART 2 – PRODUCTS

2.01 Vaults

ALL UTILITY VAULTS TO BE PLACED SHALL BE SPECIFICALLY DESIGNED FOR TELECOMMUNICATIONS APPLICATIONS, WITH NO EXCEPTIONS.

   A. Materials
      1. The Contractor shall provide pre-cast utility vaults meeting ASTM C 478 with 28-day 5500-psi minimum compressive strength concrete and designed for AASHTO H-20 loading per AASHTO HB 14. The dimensions for each utility vault shall be as noted on the drawings.
2. Utility vaults shall have tongue-and-groove double sealed joints on mating edges of pre-cast components. The joints shall firmly interlock adjoining components and provide waterproof junctions and adequate shear transfer. Joints shall be sealed with approved watertight joint sealant as prescribed in the manufacturer’s installation specifications and conforming to AASHTO M198, Type B. Sealing material shall be installed in strict accordance with manufacturer’s printed instructions.

3. Conduit Entrances
   a. For conduit installed on this project, knockout panels or pre-cast individual conduit openings may be used.
   b. On sides where no conduit is installed, 12-inch high by 12-inch wide (minimum) knockout panels for future raceway installation shall be provided.
   c. For existing utility vaults, new ducts shall enter the utility vault with factory-formed bell end of the conduit, and a seal around the conduit shall be applied after installation. Existing utility vaults shall be retrofitted with the required racking and grounding and bonding per the TIA/EIA Bonding and Grounding Standards.

4. Covers
   a. The Contractor shall provide solid covers that are rated for the location in which they are installed, with a 76.2 cm (30 in.) diameter clear opening.
   b. Heavy-duty type A 6-inch deep frames and 30-inch opening covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.
   c. The covers shall be of indented type with solid top design.
   d. The cover shall be equipped with bolt down security bolts. The bolts shall be stainless steel, flat-head Hex-socket with pin type bolts.
   e. The upper side of each cover shall have the letters “Communications” cast or burned by welder, in integral letters no less than 2 inches high. The ring of the casting shall be field stamped with utility vault or pull box numbers as indicated on the construction drawings. (1” high numbers)
   f. Double lids are required for vaults over 12-feet in length as per OSHA.

      (1) Manufacturers: Alhambra Foundry A1133; Neenah Foundry R-1750-C1SB or approved equal.

B. Manufacturers: Associated Concrete Products, Brooks Products, & Utility Vault Company or approved equivalent.

2.02 Vault Hardware

A. Materials

1. Pulling irons shall be provided, as required for the size of utility vault (minimum of 4 per utility vault: 2 placed on each end wall, top and bottom). Pulling irons shall be placed opposite the terminators. All pulling irons shall be constructed of 2.2 cm (7/8 inch) hot-dip galvanized steel.

2. A sump of 30cm (12 in.) in diameter shall be provided in each utility vault, per the manufacturer’s specifications.

3. Heavyweight cable racks with adjustable arms shall be provided for all cables in each utility vault. The racks shall be attached with adjustable inserts set in the concrete walls (bolts or studs embedded in concrete will not be used). Racks and inserts shall be centered on the side walls that
are utilized for the racking of splice cases in the utility vault, arranged so that all spare conduit ends are clear for future cable installation. The racks shall have a sufficient number of arms to accommodate cables for each conduit entering or leaving the utility vault.

4. Corner standoff brackets 15cm to 20cm (6 in. to 8 in. from wall) shall be provided if the utility vault is equipped with center exit conduits. The bracket shall extend from 15cm (6 in.) off floor to 15cm (6 in.) below roof.

5. All utility vault hardware shall be steel that is hot dip galvanized after fabrication.

6. Each utility vault shall have a detachable galvanized steel ladder that can be removed to facilitate future work in the utility vault. The ladder shall be secured to a top support arm in the utility vault opening or chimney.

B. Manufacturers

1. Hardware: Alhambra Foundry (model No. A-3382 ladder with A-3383 support bar) or Inwesco Products, or an approved equivalent product.

2. Utility vault: Brooks, Utility Vault, or Associated Concrete Products, or an approved equivalent product.

2.03 Duct Banks

A. Materials

1. Conduit

   a. Schedule 40 PVC – 4-inch inside diameter.

   b. Type C telephone conduit – 4-inch inside diameter (if concrete encased).

   c. Maxcell flexible Inner duct 3-packs (sized for the conduit) will be placed for fiber optic cable protection. A minimum of one 3-pack shall be placed in a 4-inch conduit. Other loadings shall be as otherwise specified in the plans.

2. Conduit shall have a factory formed bell on one end for interconnecting segments.

3. All conduits shall be installed in an encased steel pipe where a boring method is utilized. Grout shall be provided between conduits inside pipe and around steel pipe to fill voids per manufacturer’s specifications.

4. Spacers: High impact spacers shall be used in all multi-duct systems, for both solely owned or joint telecommunications/power construction. They shall conform to NEMA TC-2, TC-6, TC-8, and ASTM F 512 dimensions.

5. All fittings shall be designed specifically for use with the type of conduit placed.

6. All conduits shall be equipped with seal plugs in all utility vaults/handholes and expansion rubber seal plugs within all buildings.

B. Manufacturer: CARLON or approved equivalent.

2.04 Entrance Conduit

A. Conduit entering a building shall be galvanized rigid conduit (rigid steel GRC). Conduit shall transition from PVC to GRC at a distance of 24 inches beyond the exterior of the foundation to four inches AFF in the entry room. The conduits shall slope downward away from the building to reduce the potential of water entering the building. All
metal conduits shall be equipped with a plastic grommet to prevent cable damage during installation.

2.05 Locating Duct Bank Cable (Detectable Warning Tape)

A. Warning tape shall be a minimum of 3” wide, orange in color, and shall have a non-degradable imprint as follows:
   1. “Caution Telephone Cable Buried Below”
   2. “Caution Fiber Optic Cable Buried Below”

B. The tape shall be detectable.

C. Manufacturer:
   1. Carlon
      a. MAT3T61 “Caution Telephone Cable Buried below”
      b. MAT3061 “Caution Fiber Optic Cable Buried Below”
   2. Panduit
      a. HTDU3xx series Underground Hazard Tape
3. Equivalent manufacturer's type and style is acceptable.

2.06 Pull Rope

A. Pull rope shall be new 3/8" polypropylene over polyester rope with a minimum 1700 lb. tensile strength.

B. Manufacturers: CARLON: Part No.SB14105, or approved equivalent.

2.07 Bonding/Grounding

A. The reinforcing steel in the walls of the utility vault shall be bonded together and brazed to the bronze inserts of each section of the utility vault per the manufacturer's utility vault specifications. The ground inserts shall be attached to the steel rebar to provide a point of attachment for the ground wires or bonding ribbon. The inserts shall be bronze, flush mounted, and brazed to the rebar cage of all the sections of the utility vault (bottom, intermediate, and roof sections).

B. Materials

1. Bonding Ribbon: Shall be made of annealed solid copper 3/8 inch wide x 1/16 inch thick, tin-plated. Manufacturer: INWESCO Cat.12A55 or approved equivalent.

2. Bonding Ribbon Clamp: Shall be made of soft lead ½ inch wide by 1/16 inch thick and shall accept ¼ inch diameter bolt. Manufacturer: INWESCO Cat. 12A56 or approved equivalent.

3. Fargo Clamp: Shall be cast from copper, silver-plated, furnished with copper bolt. Manufacturer: INWESCO Cat.12A57 or approved equivalent.

4. Ground Rod: Shall be manufactured of high strength high carbon steel, with electrolytically bonded jacket of copper on surface, and shall meet UL spec. 467 and ANSI C-33.8-1072. Manufacturer: INWESCO Cat.12A60 or approved equivalent.

5. Ground Inserts: Shall be made of Cast Bronze W/1/4 Copper Rod. Manufacturer: INWESCO Cat.12H69 or approved equivalent.

2.08 Conduit and Raceway Tags

A. All conduits and other raceways shall be labeled with permanent type tags. Tags shall include destination engraved onto the tag. Adhesive or taped-on type markers shall not be permitted.

B. All labels shall comply with Exhibit 16720-B “Label Grammar.” Manufacturer: 3M, Tech Products Inc or Panduit.

PART 3 – EXECUTION

3.01 Vaults and Handholes

A. General

1. The Contractor shall obtain all required permits and notifications before commencing any work operations.

2. All state and local ordinances shall be complied with at all times.

3. All federal, state, and local safety rules, including OSHA, will be enforced at all times during the duration of the project. It is the responsibility of the Contractor to inspect the job site to ensure compliance.

B. Final location of all communications utility vaults and handholes shall be determined by the Contractor and the
C. All manholes to have a minimum cover of 2-feet measured from final grade to top of manhole and placed on 6 inches of compacted sand or gravel to manufacturer recommendations.

D. All conduits entering a utility vault or handhole shall be placed at right angles to the short walls and shall be sealed to prevent seepage unless otherwise specified on the construction documents.

E. Excavation dimensions shall be verified with the utility vault supplier in advance so as to prevent delays in setting schedule.

F. Shoring shall be in accordance to prevailing underground construction codes, i.e., OSHA, G. O. 128, NESC, and all applicable local, state, and federal statutes.

G. All utility vaults shall be equipped with pulling irons.

H. Finish grade shall be established prior to placing structures.

I. The Contractor and the Owner's representative shall inspect all utility vaults prior to backfilling.

J. Backfill materials shall have been sifted to provide a sand equivalent of not less than 20, and a sieve size of No.4. Backfill material shall be mechanically compacted to a minimum relative compaction of 90 percent to a level six (6) inches above final grade. The excess material shall be excavated to the final grade upon acceptance of compaction.

K. Existing and/or new communications utility vaults/handholes may be placed near the existing power and signal vault system. The Contractor shall either place new or enlarge existing utility vaults/handholes and conduits in such a manner as to not disturb existing utilities while maintaining specified clearances from all obstructions. This may require clearing much of the area around the vaults by hand. The final placement and depth shall be determined by the Contractor and the Owner's representative.

L. The Contractor shall locate all existing utilities within 20-feet of the new and/or enlarged utility vault/handhole system. The Contractor and the Owner's representative shall review and approve any revised coordination schematics. Caution shall be used when working in this area. The University's existing high power electrical conductors may be transported in the primary electrical duct structure directly adjacent to the secondary electrical and signal ducts.

M. The Contractor shall excavate around existing vaults using caution to identify and preserve all utilities in the area.

3.02 Duct Banks

A. All communications conduit banks shall be encased in 2-sack mix slurry with at least two (2) inches of concrete at the top and bottom and two (2) inches on each side. A horizontal and vertical separation of two (2) inches between the ducts shall be maintained by installing high impact spacers with horizontal and vertical locking intervals of ten (10) feet. The top surface of the concrete encasement shall include an orange color dye for future identification.

B. All communications conduit shall be placed in a uniform manner between vaults. Conduit in position #1 at one utility vault shall maintain its position within the duct run and terminate in the #1 position at the next utility vault. The position of all conduits between utility vaults shall be maintained.

C. Long radius bends (over 40 feet) shall be used whenever possible to make changes in direction. If it is found to be necessary to place a 90-degree bend in the conduit run, a factory-made sweep of no less than 150-inch (12’ 6”) radius shall be used. No conduit run shall exceed a total of 180 degrees of bend between any two points (such as utility vaults or buildings) considering both vertical and horizontal sweeps. Cold-formed trench bends
shall have a radius of not less than 40 inches and shall pass mandrel integrity. Bend radius criteria are:

1. For conduit 2” or smaller: 6 times the diameter of the conduit,
2. For conduit larger than 2”: 10 times the diameter of the conduit.

D. The length and destination of all conduits shall be identified in each utility vault, handhole, and building. Embossed metal or heavy plastic tags strapped to each conduit shall be used.

E. After installation of communications conduit and after the concrete encasement has cured, the Contractor shall prove all conduits by pulling a mandrel with a diameter ¼ inch smaller than the conduit and 6 inches long through each conduit end-to-end. An inspector designated by the Contractor and the Owner’s representative shall be notified 24 hours before this procedure. Each conduit shall be cleaned with a bristle brush to remove any debris.

F. All utility vault and handhole entrances shall be shear-blocked with standard concrete extending no less than 15 inches from the entry wall. All entering ducts shall be completely encased.

G. Utility marking tape (see 3.4.A) shall be buried 12 inches below the surface directly above the conduit.

H. All conduit structures shall be built with the telecommunications conduits placed above the power conduits with a minimum of 12 inches of separation unless otherwise called out on the construction drawings and approved in writing by the Owner’s representative. If this type of construction is required, it shall receive the prior written approval of the Owner’s representative.

I. All entrance conduits shall be securely fastened to the building. The end of the conduit located inside the building shall be sealed to prevent rodents, water, or gases from entering the building. Existing waterproofing shall be replaced like and kind. The annular space between the conduit and core shall be injected with sealant compound to fill all voids between conduit and existing wall. Grout around pipe and apply exterior waterproofing like and kind before backfilling excavation.

3.03 Entrance Conduit

A. The Contractor and the Owner’s representative shall determine the placement of all entrance conduits. All applicable standards shall be adhered to, i.e., NEC, BICSI, UCB and CPUC, General Order 128.

3.04 Locating Duct Bank Cable

A. Underground detectable warning tape shall be placed in all trenches at one foot below the final grade after the conduit and encasement is complete. The tape shall indicate the type of cable that will utilize the substructure system, e.g., fiber optic or copper cables. The detectable warning tape shall be installed according to manufacturer’s specifications to ensure access to the tape for locating purposes.

3.05 Pull Rope

A. Pull rope shall be new material that is free of knots, kinks, and abrasions.

B. Pull rope shall be placed as a single continuous length in every new duct section. (See Section 16730, 2.07.)

C. Pull rope shall be secured at each end.

3.06 Bonding/Grounding

A. Two ground rods shall be installed in each new utility vault and handhole. All non-current-carrying metal parts in the utility vault and any metallic raceway grounding bushing shall be connected to this ground rod with a No. 4/0 bare copper ground conductor and approved ground clamp, as required per NEC.
B. The grounding system shall not rely on plumbing systems.

C. Bonding conductors shall be routed with a minimum number of bends. The bends placed in the conductor should be sweeping.

D. All bonding connections shall utilize listed bolts, crimp pressure connectors, clamps, or lugs. Exothermic welding may be used.

E. Multiple bus bars shall be directly bonded together with a No. 4/0 copper conductor.

F. Backbone cabling shall be bonded at each sheath opening with, minimally, a 6-AWG copper conductor.

END OF SECTION
SECTION 16740
BUILDING RF (CATV) SYSTEM

PART 1 – GENERAL

1.01 Section Includes:
   A. Radio frequency active and passive components
   B. Optical active and passive components
   C. Support and termination hardware
   D. Documentation requirements

1.02 Related Sections
   A. Contract Terms and Conditions
   B. Section 16710 - Telecommunications General Requirements
   C. Section 16715 - Telecommunications Acceptance Testing
   D. Section 16720 - Telecommunications Basic Materials and Methods
   E. Section 16725 - Telecommunications Cable
   F. Section 16730 - Underground Structures - Telecommunications
   G. Section 16735 – Telecommunications Demolition
   H. Section 16760 - Telecommunications Grounding and Bonding

1.03 Applicable Applications
   A. As defined in section 16710 - Telecommunications General Requirements.

1.04 Submittals
   A. Prior to any Campus CATV System equipment installation, the Contractor shall submit the following product data to the Owner's representative:
      1. Main station amplifiers; Main station amplifier housings; Main station power supplies; Distribution amplifiers; Rack and wall mount amplifiers; Line directional couplers; Line splitters; Two, four, and eight-port taps.
      2. Main station amplifiers; Main station amplifier housings; Main station power supplies; Distribution amplifiers; Rack and wall mount amplifiers; Line directional couplers; Line splitters; Two, four, and eight port taps.
      3. Indoor type splitters and directional couplers; Rack mount panels; RF attenuators; Drop cable connectors. Connectors and adapters for semiflex coaxial cable (hardline; F series RF terminators; Port terminators; In-line equalizers; Self-terminating wall plate assemblies.
4. Optical transmitters; Optical receivers; Optical splitters; Optical terminators; Optical connectors; Drop type coaxial cables; Semiflex (hardline) coaxial cabling.

B. Prior to any Campus CATV System equipment installation, the Contractor shall submit three copies of the manufacturer’s installation instructions for the following equipment and components to the Owner’s representative:

1. Main station amplifiers; Main station amplifier housings; Main station power supplies; Distribution amplifiers; Rack mount amplifiers; Line directional couplers; Line splitters; Two, four and eight-port taps; Indoor type splitters and directional couplers; Rack mount panels; RF attenuators; Drop cable connectors; Connectors and adapters for semiflex coaxial cable (hardline).

C. F series RF terminators; Port terminators; In-line equalizers; Self-terminating wall plate assemblies; Optical transmitters; Optical receivers; Optical splitters; Optical terminators; Optical connectors; Flexible and drop type coaxial cables; Semiflex or hardline coaxial cables.

D. Prior to any Campus CATV System equipment installation, the Contractor shall submit:

1. Documented proof that all work undertaken on the Campus CATV System is under the direct supervision of a qualified broadband communications engineer.
   a. A “qualified broadband communications engineer” is defined as someone who can demonstrate successfully completing the design and installation of CATV systems for a period of at least five years. Also acceptable is the completion of a manufacturer’s certified training course in system design and a minimum of two years of experience. Experience shall include system design, acceptance testing, and documentation.
   b. The Contractor shall submit a copy of any valid professional designation certificate issued by the Society of Cable Telecommunications Engineers (SCTE), or an approved equivalent.
   c. The submittal will document a minimum of five completed projects utilizing products and materials similar to those involved in the current work.

2. Certification reflecting the qualifications of the technicians who will be responsible for the installation, activation, and testing of the Campus CATV System equipment.
   a. The Contractor shall submit a copy of any valid professional designation certificate issued by the Society of Cable Telecommunications Engineers (SCTE), or an approved equivalent.
   b. If no such certification exists, the Contractor shall obtain the services of certified Broadband Communications Technicians to undertake the Campus CATV System work.
3. Design schematics to the Owner's representative that reflect signal levels and expected performance figures of the system, based upon the particular equipment to be used.

4. A red-lined copy of the Campus CATV System schematics to the Owner's representative that reflects any changes based upon field conditions, product limitations, and/or the Owner's representative's request.

E. Prior to the initiation any Campus CATV System acceptance testing procedures, the Contractor shall submit certification to the Owner's representative that all Campus CATV System test equipment has been calibrated within the last six (6) months.

F. After the completion of all Campus CATV System equipment installation, the Contractor shall submit to Owner's representative:

1. As-built floor plans reflecting the coaxial cable lengths and the locations of all Campus CATV System outlets.

2. As-built schematics that reflect the component configurations, the actual locations of the equipment installed, and the method of interconnection.

3. A CD-ROM disc with the results of the Campus CATV System acceptance testing procedures.

1.05 Design Criteria

A. System shall be of a hybrid fiber coax (HFC) construction utilizing fiber trunking and with a maximum of 3 amplifiers in cascade following the fiber node.

B. System shall be designed for two-way operation, with a return frequency range of 5 to 42MHz, and a forward bandwidth of 54 to 860MHz.

C. Feeder hardline coaxial cable (semiflex) shall be at minimum of the .500" trade size. Where lengths, attenuation loss, or other factors dictate, cable shall be of the .625" trade size. Designer shall specify only one size feeder cable for the project.

D. Express feeder hardline coaxial cable shall be at minimum of the .625" trade size.

E. Node Sizes

1. In areas where the primary data connectivity is either fiber or copper Ethernet and where the CATV system will mainly serve entertainment functions, such as in offices, classrooms, conference rooms, and etc., nodes may serve multiple buildings subject to cable attenuation and the limits expressed in 1.4.A above.

2. Dormitories – if the primary data connectivity is either fiber or copper Ethernet, voice communications facilities are twisted pair copper, and the CATV system will mainly serve entertainment functions, nodes may serve multiple buildings subject to cable attenuation and the limits expressed in 1.4A above.

3. Where residential units composed of either single-family dwellings or multiple dwelling units (MDU) of eight (8) units or less are served, nodes shall serve no more than 100 dwellings.

4. Where residential units are composed of high density housing units, such as a high-rise structure, multiple nodes may be required to keep the number of units served by the node within the 100-unit limit.

5. Where it is envisioned that all connectivity, including voice, data, and video, either presently or in
the foreseeable future, will be through the CATV system, nodes shall serve no more than 50 dwelling units.

6. All nodes shall be designed and constructed in such a manner as to allow for splitting of the node into two (2) equal sections as necessary. This splitting may be achieved through either use of additional fiber and fiber transmitters and receivers or by electronic frequency stacking techniques.

F. Powering

1. All system power supplies shall be of ferro resonate design and packaged appropriately for the use intended, whether inside or outside.

2. To allow future enhancement of services without the necessity of power supply replacement, design shall provide for a maximum loading of power supplies at no more than 50% of manufacturers rating at the time of installation and system activation.

3. Non-building mounted power supplies shall be of the standby variety, with at least two hours standby time. Power supplies serving systems or portions of a system with cable telephony, shall have a minimum battery run time of two hours and shall be equipped with propane or natural gas fired generators with a minimum run time of 48 hours. Fuel selection shall be agreed upon by the University and the system designer as appropriate for the location to be served.

G. All outdoor electronics, including active and passive devices of any type shall be installed above ground in pedestals or appropriate cabinets. No device shall be installed in any vault or pull box. The only exception to this requirement is that outdoor hardline splitters and directional couplers may be installed in a communications Utility Access Hole (manhole) where appropriate and specifically permitted in writing by the Owner’s representative.

H. Drop cables shall be at a minimum type RG-56. Where applicable due to length of drop and design considerations, type 7 or RG-11 cables may be required

I. Headend and hub site interconnect cables shall be type RG-59 Headend Cabling (HEC).

J. System design levels shall be calculated to provide +6dBmV at the user outlet at the highest design channel (channel 135).

K. All station or outlet cabling shall be run to a central point and terminated on an appropriate patch panel. Daisy chaining of outlets is not permitted. No station cable shall have a loss exceeding 16dB at 900MHz

PART 2 – MATERIALS

2.01 Main Station Amplifiers

A. Materials

1. Main station amplifiers shall meet or exceed the following specifications:

   a. Return frequency range: 5 to 42 MHz.

   b. Forward frequency range of 54 to 860 MHz

   c. Forward minimum full gain: 33 dB, or as otherwise specified by the designer.

   d. Return minimum full gain of 16dB or better

   e. Variable gain control with a minimum range of 6dB or better.

   f. Fixed tilt or slope control with a minimum of 8dB highest to lowest channel.
g. Return loss: 14 dB.

h. Analog Channel loading: 129 channels.

i. Output level: 46 dBmV at 750 MHz.

j. Equipped with three or four output ports as appropriate to the design.

k. Power supplies switchable for either 60 or 90-volt operation. Power supplies for amplifiers mounted in buildings may be 120VAC line powered.

l. AC current bypass capability of 12 amps minimum for non-line powered amplifiers.

2. The Contractor shall provide all components required for a fully operational main station amplifier. These components include, but are not limited to, module chassis, attenuators, equalizers, internal DC power supply modules, return amplifier and accessories, and fuses.

B. Application: For use as a building amplifier in large multi-story University buildings.

C. Manufacturers: Motorola, model BTD-75S, or approved equivalent.

2.02 Main Station Amplifier Housings

A. Materials: Main station amplifier housing shall be designed to prohibit unauthorized access to electronic components

B. Application: Enclose the main station amplifier modules, module chassis, and internal DC power supply modules as identified above.

C. Manufacturers: Philips Broadband 9-NH series, or approved equivalent.

2.03 System Power Supplies

A. Materials

1. Power supplies shall meet or exceed the following specifications:

a. AC output voltage (VAC): 60/90 Vrms

b. AC output frequency: 60 Hz Nominal

c. AC input voltage: 120 VAC

d. AC output current: 2 to 14 Amps
2. Power supply shall be designed for use in M.D.U. or outdoor environments as appropriate for the location.

B. Application: Provide an external 60 VAC power source for the main station amplifier's internal DC power supplies.

C. Manufacturers: Invensys, Alpha Technologies, Inc., or approved equivalent.

2.04 Distribution Amplifiers and Line Extender Amplifiers

A. Materials: The distribution amplifiers shall meet or exceed the following specifications:

1. Forward frequency range: 40 to 750 MHz.
2. Gain control range: 6 dB.
3. Slope control range: 7 dB.
4. Minimum full gain 32 dB.

B. Application: For use as a building amplifier in medium and small sized University buildings and as node followers in campus wide or residential area systems.

C. Manufacturers: Philips Broadband LE90 series, or approved equivalent.

D. The Contractor shall provide all components required for a fully operational line extender amplifier. These components include, but are not limited to, module chassis, attenuators, equalizers, internal DC power supply modules, housing, return amplifier and accessories, and fuses.

2.05 Rack and Wall Mounted Amplifiers

A. Materials: The rack mount amplifiers shall meet or exceed the following specifications:

1. Forward frequency range: 54 to 860 MHz.
2. Gain control range: 6 dB.
3. Slope control range: 6 dB.
4. Gain: 34 dB.
5. Return Frequency range: 5 to 42 MHz.

B. Application: For use as a building amplifier in medium and small University buildings.

C. Manufacturers: Quality RF Services, Inc. (QRAM860-34F, QDAK860-33, or approved equivalent.

D. The Contractor shall provide all components required for a fully operational amplifier. These components include, but are not limited to, module chassis, attenuators, equalizers, internal or external DC power supply modules, and fuses.

2.06 Line Directional Couplers

A. Materials: Line directional couplers shall meet or exceed the following specifications:

1. Frequency range: 5 to 1000 MHz.
2. Housing and faceplate constructed of die cast aluminum.
3. Minimum isolation: 18 dB.
4. Designed for aerial or underground installation.

B. Application: For use in systems that require the installation of hardline coaxial cable based distribution systems.
C. Manufacturers: Motorola, SSP-K series, Scientific Atlanta, SADC series, Phillips Broadband Networks, 9-TFC series, or approved equivalent.

2.07 Line Splitters
A. Materials: Line splitters shall meet or exceed the following specifications:
   1. Frequency range: 5 to 1000 MHz.
   2. Housing and faceplate constructed of die cast aluminum.
   3. Minimum isolation: 18 dB
   4. Designed for aerial or underground installation.

B. Application: For use in systems that require the installation of hardline coaxial cable based distribution systems.
C. Manufacturers: Motorola, SSP-K series, Scientific Atlanta, SAS series, Phillips Broadband Networks, 9-TFC series, or approved equivalent.

2.08 Two, Four and Eight Port Taps
A. Materials: Taps shall meet or exceed the following specifications:
   1. Frequency range: 5 to 1000 MHz.
   2. Housing and faceplate constructed of die cast aluminum.
   3. Each tap labeled with the tap value.
   4. Port count to be determined by the design, with unused ports terminated with a 75-Ohm terminator.
   5. Designed for aerial or underground installation.

B. Application: For use in systems that require the installation of hardline coaxial cable based distribution systems.
C. Manufacturers: Motorola, SSP-K series, Scientific Atlanta, SAT series, Phillips Broadband Networks, 9000-C series, or approved equivalent.

2.09 Indoor Type Splitters
A. Materials: Indoor type splitters shall meet or exceed the following specifications:
   1. Frequency range: 5 to 1000 MHz.
   2. RFI: -130 dB.
3. **Characteristics**

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<td>4.4/8.4</td>
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<td></td>
<td>18</td>
</tr>
</tbody>
</table>

4. Capacitor decoupling on all ports

5. Medium Intermodulation Distortion


C. Manufacturers

1. Viewsonics Inc. Holland electronics, PicoMacom or approved equivalents.

2.10 **Rack Mount Panels**

A. Materials: Rack mount panels shall meet or exceed the following specifications:

1. **Size**: 3.5" X 19".

2. Designed to eliminate the requirement for drilling holes and installing screws and/or bolts through the front of the panel.

B. Application: For mounting indoor type splitters and other passive devices.

C. Manufacturers: Viewsonics Inc. (VSMP 3.50), Winsted, Inc., or approved equivalent.

2.11 **RF Attenuators**

A. Materials: Attenuators shall meet or exceed the following specifications:

1. Frequency range: 5 to 1000 MHz.

2. Accuracy of attenuation values: plus or minus .5 dB.

3. Values: 3 dB, 6 dB, 8 dB, 10 dB, 12 dB, 16 dB, and 20 dB.

B. Application: To attenuate RF signals to comply with system design criteria.

C. Manufacturers: Holland Electronics, PicoMacom, Viewsonics, or approved equivalent.

2.12 **Male “F” Cable Connectors**

A. Materials: Connectors shall meet or exceed the following specifications:

1. SCTE IPS-401 and Bellcore GR-1503-Core specifications.

2. The “F” style connectors for drop and station run coaxial cable shall be all brass construction and shall of the sealed 360-degree compression type.

3. Connectors for RG-59 and RG-6 type cables with solid center conductors shall utilize the center
4. Connectors for type 7 and RG-11 cables shall have a captive or fixed center pin with a diameter between 0.020" and 0.027"

5. Connectors shall be rated for use through 1000MHz.

6. RF shielding: -95dB

7. Return loss: -30 dB up to 1 GHz.

8. Only an “F” connector recommended by the cable manufacturer shall be installed.

B. Applications

1. Terminate coaxial cables at the tap, outlet, and on various CATV equipment

C. Manufacturers: Gilbert Engineering, Inc., Thomas & Betts Corp., or approved equivalent.

2.13 “F” Adapters

A. All adapters, including double female or bulkhead connectors shall be rated for use through 1000MHz.

B. F-81 double female connectors shall utilize a round seizing pin construction, with a contact resistance of less than 6 milliohms, and a 1000MHz return loss of 20dB or better.

C. Return loss at 1000MHz of 25dB or better.

D. Applications: used in various locations in the system for 90-degree angles, installation on wall plates and etc.

E. Manufacturers: For F-81 double female connectors, Holland Electronics, G-F811, other items, Holland Electronics, Pico MaCom, Viewsonics

2.14 Hardline Connectors and Splices

A. Materials: Connectors shall meet or exceed the following specifications:

1. Return loss: -30 dB up to 1 GHz.

2. Pull force meets or exceeds yield strength of the cable.

3. Operational temperature range: -40 degrees F to 170 degrees F.

4. Manufactured from aluminum alloy and coated with iridite.

5. Equipped with silver plated brass terminals.

6. Shall be re-enterable and reusable.

7. Only connectors recommended by the cable or connector manufacturer shall be installed.

8. Connectors, other than direct entry type, which may be two-piece, shall be of three-piece construction with an integral stainless steel sleeve.

B. Applications
1. Terminate hardline coaxial cables on the CATV system RF active and passive components.

C. Manufacturers: Gilbert Engineering, Inc., GRS series, Thomas & Betts Corp., or approved equivalent.

2.15 F Series RF Terminators
A. Materials: F series RF terminators shall meet or exceed the following specifications:
   1. Frequency range: 5 to 1000 MHz.
B. Applications
   1. To be installed on all unused ports on various port taps, splitters, and other devices.
   2. To be installed on all CATV system equipment test points.
C. Manufacturers: Gilbert Engineering Co., Inc. (GTR-59-S), Thomas & Betts Corp., or approved equivalent.

2.16 Port Terminators
A. Materials: Port terminators shall meet or exceed the following specifications:
   1. Frequency range: 5 to 1000 MHz.
B. Application: To be installed on the output port of the CATV system passive component at each end of line.
C. Manufacturers: Gilbert Engineering Co., Inc., GTR series, Thomas & Betts Corp., or approved equivalent.

2.17 In Line Equalizers
A. Materials: In line equalizers shall meet or exceed the following specifications:
   1. Frequency range: 5 to 1000 MHz.
   2. Values: 3 dB, 6 dB, and 9 dB.
B. Application: To equalize RF signals to comply with system design criteria.
C. Manufacturers: Toner Cable Equipment, Inc. (XEQ-99-value), Signal Vision Inc., or approved equivalent.

2.18 Self Terminating Wall Plate Assembly
A. Materials: Self terminating wall plate assembly shall meet or exceed the following specifications:
   1. Termination: 75 Ohms.
   2. Equipped with a flush ivory plastic plate.
B. Application: Designed to provide automatic termination of interface when mating connector is disconnected.
C. Manufacturer: Thomas & Betts Corp. (TF81I), custom order item, no other source known.

2.19 Flexible and Drop Type Cables
A. Materials: Coaxial cabling shall meet or exceed the following specifications
1. Cable shall be factory swept over a frequency range of 5 to 1000MHz, with a structural return loss of 20dB or better.

2. All interior coaxial cabling shall be at a minimum, UL rated CATV. Where determined necessary by the designer or the State Fire Marshall, cable shall be of the plenum type.

3. Cabling shall have a minimum of 90% braid, with full aluminum laminated tape shield overlapped and bonded to the center conductor dielectric insulating material.

4. Cabling shall have a nominal impedance of 75+-3 ohms.

5. Dielectric shall be gas-expanded foam appropriate to the construction of the cable. Nominal velocity of propagation shall be no less than 82%.

6. Drop and horizontal run cable center conductor may be either solid copper or copper clad steel with a minimum size as shown:
   a. RG-59 – 20 AWG
   b. RG-6 – 18 AWG
   c. RG-11 – 14AWG

7. Drop and horizontal run cabling shall at a minimum be of type RG-6.

8. RG-59 headend cable shall be of the quad shield type, with a silver plated, copper coated steel center conductor.

9. Cabling installed in underground conduits or wet locations shall have a flowable flooding compound between the jacket and shield.

10. All cable shall have a maximum manufacturer rated loss per 100 feet of no greater than the following, numbers in dB:

<table>
<thead>
<tr>
<th>Type</th>
<th>10MHz</th>
<th>50MHz</th>
<th>400MHz</th>
<th>900MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-59</td>
<td>0.80</td>
<td>1.88</td>
<td>5.40</td>
<td>8.10</td>
</tr>
<tr>
<td>RG-6</td>
<td>0.65</td>
<td>1.46</td>
<td>4.46</td>
<td>7.5</td>
</tr>
<tr>
<td>Type 7</td>
<td>0.55</td>
<td>1.25</td>
<td>3.27</td>
<td>5.0</td>
</tr>
<tr>
<td>RG-11</td>
<td>0.45</td>
<td>1.11</td>
<td>4.16</td>
<td>4.0</td>
</tr>
</tbody>
</table>
2.20 Semiflex Hardline Cables

A. Materials: Coaxial cabling shall meet or exceed the following specifications

1. Cable shall be factory swept over a frequency range of 5 to 1000MHz, with a structural return loss of 20dB or better.

2. Hardline coaxial cabling used inside shall be at a minimum, UL rated. Where determined necessary by the designer or the State Fire Marshall, cable shall be of the plenum type.

3. Cabling shall have a nominal impedance of 75 +/- 3 ohms.

4. Dielectric shall be gas-expanded foam appropriate to the construction of the cable. Nominal velocity of propagation shall be no less than 82%.

5. Center conductor shall be solid copper or copper coated aluminum. The minimum center conductor diameter shall be as follows:
   a. Type 500 (1/2") 0.109"
   b. Type 625 0.135"
   c. Type 750 3/4") 0.166"
   d. Type 1000 0.194"

6. Cabling installed in underground conduits or wet locations shall have a flowable flooding compound between the jacket and shield.

7. All cable shall have a maximum manufacturer rated loss per 100 feet of no greater than the following numbers in dB:

<table>
<thead>
<tr>
<th>Type</th>
<th>5MHz</th>
<th>50MHz</th>
<th>400MHz</th>
<th>900MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>.500</td>
<td>0.18</td>
<td>0.56</td>
<td>1.55</td>
<td>2.40</td>
</tr>
<tr>
<td>.625</td>
<td>0.14</td>
<td>0.46</td>
<td>1.28</td>
<td>2.0</td>
</tr>
<tr>
<td>.750</td>
<td>0.12</td>
<td>0.37</td>
<td>1.06</td>
<td>1.65</td>
</tr>
<tr>
<td>.875</td>
<td>0.10</td>
<td>0.33</td>
<td>0.92</td>
<td>1.44</td>
</tr>
<tr>
<td>1.000</td>
<td>0.09</td>
<td>0.29</td>
<td>0.85</td>
<td>1.38</td>
</tr>
</tbody>
</table>
2.21 Forward and Return Optical Transmitters

A. Materials: Optical transmitters shall meet or exceed the following specifications:

1. Forward RF input operational bandwidth: 50 – 860 MHz.
2. RF input impedance: 75 Ohms.
3. RF input connector: Type “F”.
4. RF input automatic gain control range: plus or minus 5 dB.
5. Equipped with DFB opto-isolated laser diode.
6. Optical output wavelength: 1310 nm, plus or minus 20 nm.
7. Optical output power: 7mW minimum, or as specified by the designer.
8. Equipped with SC/APC output connector.

B. Applications

1. Convert a broadband RF signal to a broadband optical signal in the CATV system headend.
2. Transport a broadband optical signal to the optical receivers located in the University buildings.

C. Manufacturers: Philips Broadband, or approved equivalent.

2.22 Forward and Return Optical Receivers

A. Materials: Optical receivers shall meet or exceed the following specifications:

1. Optical input wavelength: 1310 nm, plus or minus 20 nm.
2. Receiver type: PIN detector.
3. RF output connector: Type “F”.
4. Forward RF output operational bandwidth: 50 – 860 MHz.
5. RF output impedance: 75 Ohms.
6. Tilt: flat across the spectrum.
7. Optical input connector: FC/APC.
8. Standard RF output level: +20 dBmV.
9. High RF output level: +37 dBmV.

B. Optical receivers may be configured as follows:
1. Separate optical receiver and distribution amplifier designed for installation in 19" rack.
2. Integrated optical receiver and distribution amplifier designed for installation in 19" rack.

C. Applications
1. Convert a broadband optical signal to a broadband RF signal.
2. Provide a broadband RF signal to the CATV distribution systems in the University buildings.
3. Node mounted optical receiver and distribution amplifier.

D. Manufacturers
2. Blonder Tongue Laboratories, Inc.
3. Approved equivalent.

2.23 Optical Splitters 1x2, 1x4, 1x8

A. Materials: Optical splitters shall meet or exceed the following specifications:
1. Center wavelength: 1310 nm, plus or minus 20 nm
2. Maximum insertion loss for 1 X 8 splitter: 11.5 dB
3. Equipped with SC / APC connector on 2 meter input pigtail
4. Equipped with SC / APC connectors on 2 meter output pigtails
5. Configured for 19" rack mounting
6. Designed to prohibit unauthorized access to components

B. Application: Split an optical signal from a single input fiber and divide it equally among eight output fibers.

C. Manufacturers: Fiberdyne Labs, Inc., (F27-70022-22), Blonder Tongue Laboratories, Inc., or approved equivalent.

2.24 Optical Terminators

A. Materials: Optical terminators shall meet or exceed the following specifications:
1. Center wavelength: 1310 nm, plus or minus 20 nm.
2. Designed to mate with SC / APC connectors.

B. Applications
1. Terminate unused optical splitter ports.
2. Prevent undesirable back reflections.

C. Manufacturers: Fiberdyne Labs, Inc. (FTFCAPC), Fotec, Inc., or approved equivalent.
2.25 Optical Connectors
A. Materials: Optical connectors shall meet or exceed the following specifications:
   1. Bellcore GR-326, Issue 3
   2. Configured as a pigtail cable assembly suitable for fusion splicing
   3. Pigtail shall consist of high quality single mode fiber optic cable
   4. Equipped with a single SC / APC connector
   5. Equipped with strain relief boots
   6. Back reflections: -60 dB
B. Applications: Terminate single mode fiber optic cables on the CATV system active and passive optical components.
C. Manufacturers: Telect, Inc. (520-2000-001-XP), Molex, Inc., or approved equivalent.

2.26 Miscellaneous Hardware
A. The Contractor shall provide and install all hardware necessary to produce a fully operational Campus CATV System.
B. Miscellaneous hardware shall include but is not limited to nuts, bolts, washers, screws, cable ties, straps, spacers, hooks, sleeves, strain relief's, clamps, arms, braces, and brackets.

PART 3 – EXECUTION

3.01 Scope of Work
A. The Contractor shall be responsible for the professional installation of all Campus CATV System passive and active components.
B. The Contractor shall provide all test and measurement equipment required for the Campus CATV System proof of performance testing procedures. Refer to Specification Section 16715 – Telecommunications Acceptance Testing for the requirements.

3.02 Complete System
A. The Contractor is responsible for coordinating the installation and activation of the Campus CATV System to ensure that a complete and fully operational system is available for use by the University.
B. The Contractor is not responsible for interconnection to the local CATV system, the installation of a VHF/UHF antenna system, and/or the installation of a satellite antenna system.

3.03 General Installation Guidelines
A. All Campus CATV System installation and activation work shall be performed according to published industry guidelines, rules and regulations. If a dispute occurs, local, state and national codes have precedence; then University policies and procedures; then standards such as Electronics Industry Association (EIA), the National Cable Television Association (NCTA), Society of Cable Telecommunications Engineers (SCTE; then finally, the manufacturer's recommendations.
B. All work shall be installed and constructed at the highest level of quality workmanship and professionalism.

3.04 Detailed Distribution System Design

A. The Contractor shall provide the submittals identified in Section 1.4 before beginning any work on the Campus CATV System identified in this section.

B. The Campus CATV System design submittals shall approximate the level of detail commonly expected for such applications, with the addition of projected loss figures based upon actual products to be used and the actual length of each coaxial and/or fiber optic cable run.

C. The Contractor shall ensure that the Campus CATV System meets or exceeds the following system design criteria at any and all Campus CATV System drops:

1. Minimum signal level: 6 dBmV
2. Maximum signal level: 12 dBmV
3. Maximum difference between adjacent video carriers: 1 dB
4. Maximum difference between any video carriers: 7 dB
5. Carrier to noise ratio: 43 dB (minimum)
6. Hum: 1%

3.05 Main Station Amplifiers

A. The Contractor shall install the main station amplifiers according to the manufacturer’s recommendations.

B. The Contractor shall provide all additional components required for a fully operational main station amplifier. These components include, but are not limited to, attenuators, equalizers, internal power supply, and fuses.

C. The main station amplifiers shall be installed in a properly configured main station amplifier housing.

3.06 Main Station Amplifier Housings

A. The Contractor shall install the main station amplifier housings according to the manufacturer’s recommendations.

B. The Contractor shall provide all mounting hardware required for the proper installation of the main station amplifier housings.

C. The main station amplifier housings shall be installed on the walls of the telecommunications rooms identified on the CATV system design schematics.

3.07 System Power Supplies

A. The Contractor shall install the main station power supplies according to the manufacturer’s recommendations.

B. The Contractor shall provide all mounting hardware required for the proper installation of the main station power supplies.

C. The main station power supplies shall be installed on the walls of the telecommunications rooms identified on the CATV system design schematics.

3.08 Distribution Amplifiers and Line Extenders
A. The Contractor shall install the distribution amplifiers according to the manufacturer's recommendations.

B. The Contractor shall provide all mounting hardware required for the proper installation of the distribution amplifiers.

C. The Contractor shall provide all additional components required for a fully operational distribution amplifier. These components include, but are not limited to, attenuators, equalizers, internal power supply, and fuses.

D. The distribution amplifiers shall be installed on the walls of the telecommunications rooms identified on the CATV system design schematics.

3.09 Rack Mount Amplifiers

A. The Contractor shall install the rack mount amplifiers according to the manufacturer's recommendations.

B. The Contractor shall provide all additional components required for a fully operational rack mount amplifier. These components include, but are not limited to, attenuators, equalizers, internal power supply, and fuses.

C. The rack mount amplifiers shall be installed in an equipment rack located in the telecommunications rooms identified on the CATV system design schematics.

3.10 Line Directional Couplers

A. The Contractor shall install the line directional couplers according to the manufacturer's recommendations.

B. The Contractor shall connect the line directional couplers as depicted in the Contract Documents.

3.11 Line Splitters

A. The Contractor shall install the line splitters according to the manufacturer's recommendations.

B. The Contractor shall connect the line splitters as depicted in the Contract Documents.

3.12 Taps

A. The Contractor shall install the eight port taps according to the manufacturer's recommendations.

B. The Contractor shall connect the eight port taps as depicted in the Contract Documents.

3.13 Indoor Type Splitters

A. The Contractor shall install the indoor type splitters according to the manufacturer's recommendations.

B. No indoor type splitters are to be used on any CATV system station cable or outlet.

C. The Contractor shall connect the indoor type splitters as depicted in the Contract Documents.

3.14 Rack Mount Panels

A. The Contractor shall install the rack mount panels according to the manufacturer's recommendations.

B. The Contractor shall mount the RF splitters on the rack mount panels.

C. The rack mount panels shall be installed in the equipment rack, as depicted in the Contract Documents.
3.15 RF Attenuators

A. It is recommended that the Contractor measure the signal levels at all of the Campus CATV System outlets prior to ordering the RF attenuators to accurately identify the values and quantities required.

B. The Contractor shall install the RF attenuators according to the manufacturer’s recommendations.

C. The Contractor shall provide and install the RF attenuators, as required, to provide the RF levels identified in the Campus CATV System design criteria.

D. The Contractor shall install the RF attenuators on the output ports of the eight port taps or the RF splitters.

3.16 F-56 Connectors

A. The Contractor shall install the F-56 connectors according to the manufacturer’s recommendations.

B. The Contractor shall provide and install the F-56 connectors on all CATV System equipment interconnection cables and drop cables.

C. The Contractor shall only utilize crimping tools recommended by the cable and/or connector manufacturers.

3.17 .500 Connectors

A. The Contractor shall install the .500 connectors according to the manufacturer’s recommendations.

B. The Contractor shall provide and install the .500 connectors on all CATV distribution system cables.

C. The Contractor shall only utilize installation tools recommended by the cable and/or connector manufacturers.

3.18 F Series RF Terminators

A. The Contractor shall install the F series RF terminators according to the manufacturer’s recommendations.

B. The Contractor shall provide and install an F series RF terminator on all unused splitter ports.

C. The Contractor shall provide and install an F series RF terminator on all unused ports on the eight port taps.

D. The Contractor shall provide and install an F series RF terminator on all CATV system equipment test points.

3.19 In Line Equalizers

A. It is recommended that the Contractor measure the signal levels at all of the Campus CATV System outlets prior to ordering the in line equalizers to accurately identify the values and quantities required.

B. The Contractor shall install the in line equalizers according to the manufacturer’s recommendations.

C. The Contractor shall provide and install in line equalizers, as required, to provide the RF levels identified in the CATV system design criteria.

D. The Contractor shall install the in line equalizers, after the RF attenuator (if applicable), on the output ports of the RF splitters.

3.20 Self Terminating Wall Plate Assemblies

A. The Contractor shall install the self-terminating wall plate assemblies according to the manufacturer’s
B. The self-terminating wall plate assemblies are a custom order item with a four- (4) week lead-time. Also, all orders shall be made in multiples of twenty (20) units.

C. The Contractor shall install self-terminating wall plate assemblies at all Campus CATV System outlets.

3.21 Optical Transmitters

A. The Contractor shall install the optical transmitters according to the manufacturer's recommendations.

B. The Contractor shall provide and install all appropriate LASER warning signs.

C. The Contractor shall install the optical transmitters in the equipment rack, as depicted in the Contract Documents.

3.22 Optical Receivers

A. The Contractor shall install the optical receivers according to the manufacturer's recommendations.

B. The Contractor shall provide and install all appropriate LASER warning signs.

C. The Contractor shall install the optical receivers in the equipment rack, as depicted in the Contract Documents.

3.23 Optical Splitters

A. The Contractor shall install the optical splitters according to the manufacturer's recommendations.

B. The Contractor shall provide and install the optical splitters at the output of the optical transmitters, as identified in the Contract Documents.

C. The Contractor shall install the optical splitters in the equipment rack, as depicted in the Contract Documents.

3.24 Optical Terminators

A. The Contractor shall install the optical terminators according to the manufacturer's recommendations.

B. The Contractor shall provide and install the optical terminators to prevent undesirable back reflections from unused optical splitter ports.

C. The Contractor shall install the optical terminators in the fiber optic patch panels

3.25 Optical Connectors

A. The Contractor shall install the optical connectors according to the manufacturer's recommendations.

B. The Contractor shall provide and install the optical connectors on the single mode optics designated for use by the Campus CATV System.

C. The Contractor shall connect the optical connectors to the connector panels in the fiber optic patch panels, as depicted in the Contract Documents.

3.26 Documentation Requirements

A. Prior to installation of the Campus CATV System equipment, the Contractor shall provide all documentation,
identified in #1.4 Submittals, to the Owner’s representative.

B. After installation of the Campus CATV System equipment, the Contractor shall provide as-built floor plans reflecting the coaxial cable lengths and the locations of all Campus CATV System outlets to the Owner’s representative.

C. After installation of the Campus CATV System equipment, the Contractor shall submit as-built schematics that reflect the component configurations, the actual locations of the equipment installed, and the method of interconnection to the Owner’s representative.

3.27 Acceptance Testing Procedures

A. Refer to Section 16715 – Telecommunications Acceptance Testing for the complete testing requirements.

B. One week prior to beginning the Campus CATV System Acceptance Testing procedures, the Contractor shall submit to the Owner’s representative a detailed acceptance testing plan identifying the type of tests to be performed, the location of such tests, and the time the tests are expected to take place.

C. A qualified University representative shall witness all Campus CATV System acceptance-testing procedures.

D. All Campus CATV System test equipment shall be calibrated within the last six (6) months and such certification shall be submitted to the Owner’s representative prior to conducting the Campus CATV System acceptance testing procedures.

E. The Contractor shall perform and document all tests and measurements recommended and/or required by the manufacturer of the individual products installed in the Campus CATV System.

F. The Contractor shall perform and document all applicable tests and measurements as described in the latest version of the National Cable Television Association (N.C.T.A.) Recommended Practices for Measurements on Cable Television Systems.


H. The Contractor shall provide the Owner’s representative with the results of the Campus CATV System acceptance testing procedures.

I. The Owner’s representative shall conduct a final inspection of the completed Campus CATV System and issue a detailed punch list that describes all corrections, adjustments, and/or other recommended procedures required.

J. The final acceptance of the Campus CATV System shall be after the Owner’s representative and the University reviews and approves the results of the Campus CATV System acceptance testing procedures.

K. The final acceptance of the Campus CATV System shall be after the Contractor completes any corrections, adjustments and/or other recommended procedures required by the punch list.

L. The final acceptance of the Campus CATV System shall be after the Contractor submits the Campus CATV System as-built drawings to the Owner’s representative for review and approval.

END OF SECTION
SECTION 16760

TELECOMMUNICATIONS GROUNDING AND BONDING

PART 1 – GENERAL

1.01 Section Includes:

A. Related Sections
B. Applicable Publications
C. Work Sequencing and Coordination
D. Telecommunications Submittals
E. Quality Assurance
F. Project Record Documents
G. Qualifications
H. Regulatory Requirements
I. Performance Requirements
J. Materials
K. Execution

1.02 Related Sections

A. Division 16 Electrical Sections apply to this Section with the additions and modifications specified herein.
B. Section 16710 - Telecommunications General Requirements
C. Section 16715 - Telecommunications Acceptance Testing
D. Section 16720 - Telecommunications Basic Materials and Methods
E. Section 16725 - Telecommunications Cable
F. Section 16730 - Underground Structures – Telecommunications
G. Section 16735 – Telecommunications Demolition

1.03 Applicable Publications

B. Electronic Industries Alliance and Telecommunication Industries Association (EIA/TIA) Publications:
   1. EIA/TIA 568A - Commercial Building Telecommunications Wiring Standard
2. EIA/TIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces
3. TIA/ATIS JSTD-607-A - Commercial Building Grounding and Bonding Requirements for Telecommunications

C. Institute of Electrical and Electronic Engineers (IEEE) Publication: 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems

D. National Fire Protection Association (NFPA) Publication: 70-96 National Electrical Code (NEC)

E. The California State University (CSU), Office of the Chancellor, Publication: Telecommunications Infrastructure Planning Standards, including any supplements

F. Underwriters Laboratories, Inc. (U.L.) Publication:
   1. 83-1983 Thermoplastic Insulated Wires
   2. 467-84 (R86) Grounding and Bonding

1.04 Work Sequencing and Coordination

A. The Contractor shall coordinate interconnection to the University’s existing grounding and bonding system with the Owner’s representative. All connections to the existing buildings systems should be performed without affecting the existing building grounding system. However, if any out of service activity is required, the work shall be coordinated a minimum of fourteen (14) days in advance with the Owner’s representative.

1.05 Submittals

A. The Owner’s representative shall receive the following Contractor submittals:

B. Product data for:
   1. Ground bus bars
   2. Conductors
   3. Connections (all types)

C. Test Reports for point-to-point resistance tests.

D. Manufacturer’s Instructions: include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

1.06 Quality Assurance

A. All grounding and bonding system work shall be tested and documented as defined in Section 16715 - Telecommunications Acceptance Testing.

B. For products or workmanship specified by association, trade, Federal, or State Standards, the Contractor shall comply with the requirements of the standard, except when more rigid requirements required by applicable codes or University standards shall apply.

C. The Contractor shall conform to reference standard by date of issue current on final design documents.

1.07 Project Record Documents
A. The Contractor shall accurately record and submit to the Owner’s representative complete data regarding signal ground wire pathways, points of bonding, and point of connection to building grounds.

1.08 Qualifications

A. Products specified in this Section shall be manufactured by a company with a minimum of three years’ documented experience specializing in manufacturing such products.

B. The contractor shall provide the Owner’s representative with a letter or product specification catalog from the manufacturer as evidence of the three years of documented experience listed above.

1.09 Regulatory Requirements

A. Telecommunications grounding and bonding shall conform to requirements of NFPA 70 and ANSI C2.

B. The Contractor shall furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to the Owner’s representative as suitable for purposes specified and shown.

1.10 Performance Requirements

A. Point-to-Point Resistance: 0.5 ohms or less.

PART 2 – MATERIALS

2.01 Materials and Equipment

A. Materials and equipment shall conform to the respective standards and to the specifications stated herein. Electrical ratings shall be as indicated. Except where specifically indicated otherwise, the Contractor shall provide only new materials having all legally required approvals and/or labels. Materials shall conform to the requirements of UL 467 where applicable.

2.02 Conductor, UL 83

A. Ground and bonding conductors shall be green-insulated, soft-drawn stranded copper conductors, unless otherwise indicated, installed with sufficient slack to avoid breaking due to settlement and movement of conductors or attached points.

B. System grounding conductors shall be minimum of 3/0 AWG bare copper, unless otherwise indicated, and shall be continuous with no joints or splices.

2.03 Connectors and Terminals

A. Wire Connectors and Terminals for use with Copper Conductors: UL 486A.

2.04 Ground Bus Bars

A. The Contractor shall provide ground bar with tapped standard NEMA bolt holes for 2-hole compression connectors, mounting brackets and insulators, sizes as indicated:

1. 1/4" x 4" x 20" (min), Lyncole XIT or approved equal for use as TMGB (1 per building).

2. 1/4" x 4" x 10" (min), Lyncole XIT or approved equal for use as TGB (1 per Telecom Space).

PART 3 – EXECUTION

3.01 Installation
A. The Contractor shall provide grounding and bonding in accordance with the requirements of NFPA 70, IEEE 142, EIA/TIA 568, TIA/ATIS JSTD-607-A, state and local codes, the campus standards and to requirements specified herein. Codes shall be complied with as a minimum requirement, with these specifications prevailing when they are more stringent.

3.02 Bonding

A. Metallic conduits, wire ways, metal enclosures of bus ways, cable boxes, equipment housings, cable racks and all non-current carrying metallic parts of the installed telecommunications services shall be grounded with #6 AWG copper wire. The metallic conduit system shall be used for equipment and enclosure grounding but not as a system ground conductor.

B. All metallic conduit stub-ups shall be grounded, and where multiple stub-ups are made within an equipment enclosure, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.

C. Each metallic raceway, pipe, duct and other metal object entering the buildings shall be bonded together. The Contractor shall use #6 AWG bare copper conductors.

D. The Contractor shall bond telecommunications equipment and bus bars separately.

E. Rack mounted equipment shall be bonded to the rack using bonding screws and/or washers.

3.03 Signal Reference Grounding and Bonding

A. Each identified telecommunications space within a building shall have a common signal reference ground. The signal reference ground shall conform to the following:

1. Within the building, all communication spaces shall be separately bonded to each other and connected to the primary building ground in accordance with the provisions of TIA/ATIS JSTD-607-A. The communication ground shall not ground any other equipment or be connected to any potential high voltage source. All racks, frames, drain wires, and all installed communication equipment shall only be grounded to this common reference ground with a minimum size #6 AWG copper wire.

2. The Contractor shall provide, as a minimum, a continuous #3/0 AWG green electrical conductor connected to a 1/4" x 4" x 10" telecommunications grounding bus bar (TGB) 6" AFF on the plywood backboard of each IDF (or telecommunication space) to terminate chassis and other equipment grounds.

3. The ground wires from each individual IDF shall be routed directly to the Building Distribution Frame (BDF), terminated and bonded together via a telecommunications main grounding bus bar (TMGB) of minimum 1/4" x 4" x 20" dimensions. This point of single reference for all closets in a building shall in turn be grounded with a minimum #3/0 AWG ground conductor to the main building ground. If a main building ground is unavailable, the ground wire from the BDF shall be grounded to the nearest electrical panel ground bus bar. The building ground for signal reference shall be the building service entrance ground.

4. The TMGB and TGB shall be bonded to building steel where applicable.

3.04 Riser/Tie Cable Grounding

A. There shall be no bonding between the entry cable and the inside riser or distribution cable.

B. All riser and tie cable shields shall be bonded into a single continuous path end-to-end and grounded on each floor in which pairs leave the sheath. Cable shields shall be grounded to the signal reference ground provided in each telecommunication space.
3.05 Field Tests

A. As an exception to requirements that may be stated elsewhere in these documents, the Owner’s representative shall be given five (5) working days notice prior to each test. The Contractor shall provide all test equipment and personnel and shall provide written copies of all test results.

B. Grounding and bonding system conductors and connections shall be inspected for tightness and proper installation.

C. The Contractor shall provide personnel and test equipment for point-to-point resistance tests before connecting equipment. Perform point-to-point tests in each building to determine the resistance between the main grounding system and all BDF/IDF ground bus bars. Investigate and correct point-to-point resistance values that exceed 0.5 ohm. The Contractor shall record resistance measurements at all test point locations.

END OF SECTION
SECTION 16800
SECURITY ELECTRICAL

PART 1 – GENERAL

1.01 Summary
A. Section includes: All security conduit pull-boxes, and junction boxes:

1.02 Related Sections and Drawings
A. Section 16000, Electrical
B. Section 13710, Access Control System
C. Section 13720, Alarm Monitoring System
D. Section 13730, Closed Circuit Television System
E. Section 14xxx, Elevator Card Reader
F. Security Drawings
G. Electrical Drawings

1.03 Drawing and Specifications
A. Reference Security Drawings for low voltage conduit requirements
B. Reference Electrical Drawings and specifications for security power requirements

1.04 Scope of Work
A. Provide all conduit, pull-boxes, and junction boxes for security cabling as shown on the security drawings.

B. Conduit shall be run from wall mounted security devices associated with a door, i.e., card readers and other door devices, to a 6 inch high x 6 inch wide x 4 inch deep junction box located below the raised floor near the door.

1. Provide 1/2” conduit from junction box to each of the following places
   a. Card reader centered 38-1/2 inches above finished floor.
   b. Electric locking hardware field verify location on door.
   c. Door contact and passive infrared detector at door header; field verify location.
C. Provide and install one (1), three (3) foot by four (4) foot, three-quarter (3/4) inch deep fire-rated plywood backboard for the mounting of all security equipment in the mechanical equipment/telecom room, and mount a twenty-four (24) inch by six (6) inch by six (6) inch electrical gutter at the top of the plywood backboard.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION
SECTION 16900
ELECTRICAL CONTROLS

PART 1 – GENERAL

1.01 Related Documents

A. Drawings. Construction Services Agreement, including General and Special Conditions and Division-1 Specification Sections, apply to work specified in this Section.

1.02 Description

A. General: Work Specified Under This Section:

1. Interlock Controls: Except as noted, all relays, relay enclosures, H-O-A and pilot light stations, junction boxes, conduits and conductors, as detailed or called for on the drawings for equipment under all divisions, shall be furnished and installed under this Section. All wiring (low and line voltage) for control and interlocking of mechanical and plumbing equipment motors is furnished under this Section and is part of the Electrical Work if indicated on the drawings or in these specifications.

B. Work Included in This Section, But Specified Elsewhere:

1. Refer to Section 16050 for Basic Materials and Methods to be used in accomplishing the work specified in this Section.

2. Refer to Section 16920 for Motor Control Centers related to work under this Section.

C. Related Work Furnished Under Other Sections:

1. The following items are furnished and installed under another Section and are connected under this Section:

   a. Starters for chillers.

   b. Variable Frequency Drives (VFD)

   c. Electric motors for HVAC or plumbing equipment.

   d. Detailed wiring diagrams and equipment specifications related to mechanical and interlock wiring.

1.03 Submittals

A. Submit, in conformance with the requirements of Electrical General Provisions. Section, the following items:

1. Selector switches.

2. Pilot lights.


PART 2 – PRODUCTS

2.01 Control Relays
   A. 600 volt AC, 10 ampere rated, electrically held, convertible type, plug-in, color coded, manually operable contacts with continuous duty, impregnated, molded operating coil, voltage as required or indicated on drawings. Potter Brumfield or equal.

2.02 Pushbutton Switches
   A. Operator: Oil-tight, panel-mounted, full guarded, non-illuminated momentary actuator button with red color.
   B. Contact Blocks: Single-pole, double-throw, double break contacts rated 10 amps continuous at 120 volts, 60 Hz.

2.03 Pilot Light
   A. Description: Oil-tight, push to test, panel-mounted red light with rear illuminated plastic lens cap of color indicated on the drawings.
   B. Light Module: 120 volt, 60 Hz, transformer type for General Electric GE44 lamp, Westinghouse, or approved equal.

2.04 Selector Switches
   A. Description: Oil-tight, 3 position, non-illuminated manual return operator with standard, black plastic switch knob.
   B. Contact Blocks: Single pole, double-throw, double break, silver contacts rated 10 amperes continuous at 120 volt, 60 Hz, with molded phenolic housing of stackable design.

PART 3 – EXECUTION

3.01 Controls
   A. Circuits and verify functions with Mechanical Contractor.
   B. Coordinate connection of chiller starters and all package control panels with Mechanical Division of Specifications.

END OF SECTION
SECTION 16901

ELECTRICAL SENSING AND MEASUREMENT

PART 1 – GENERAL

1.01 Summary

A. Instrument transformers.
B. Power monitors.

1.02 References

A. ANSI C12 - Code for Electricity Metering.
B. ANSI C37.9 - Surge Withstand Testing.
C. ANSI C57.13 - Requirement for Instrument Transformers.
D. CEC • California Electrical Code.

1.03 Submittals

A. Comply with provisions of Division 1- SUBMITTALS.
B. Product Data: Provide electrical ratings, adjustment ranges, enclosure type, outline dimensions, mounting dimensions, and terminal connection information.

1.04 Quality Assurance

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum of 3 years experience.
B. Furnish products listed and classified by Underwriters Laboratories, Inc. And suitable for purpose specified and indicated.

PART 2 – PRODUCTS

2.01 Electrical Power Monitors

A. Manufacturers:

1. Power Measurement Limited, Model 3710 ACM.
2. Square D, Model Power Logic.
4. Westinghouse, Model IQ Data Plus II.

B. Instantaneous value readouts:

1. Frequency.
2. Temperature
3. Current, per phase RMS.
4. Current, 3-phase average RMS.
5. Current, apparent RMS.
7. Power factor, per phase.
8. Power factor, 3-phase total.
9. Real power, 3-phase total.
10. Reactive power, 3-phase total.
11. Apparent power, 3-phase total.

C. Demand value readouts:
1. Average demand current, per phase.
2. Peak demand current, per phase.
3. Average demand, real power.
4. Predicted demand, real power.
5. Peak demand, real power.

D. Energy value readouts:
1. Accumulated energy.
2. Accumulated reactive energy.

E. Provide true RMS measurements accurate to 1% voltage and current sensing.

F. Connect direct to PI's and CT's for voltage and current sensing. Acceptable to connect directly to line voltage for systems rated at 4801277 volts or less.

G. Provide non-volatile memory storage for measured data.

H. Provide 6 digit (minimum) LED or LCD display.

I. Field programmable. Stored data protected from accidental erasing.

J. Provide signal compatible with project BEMS.
1. KWH demand via pulse.
2. Voltage, Ampere, KW Demand and Power Factor via 4·20mA or 0-5 VDC signal.

K. Provide KYZ pulse initiator.
L. Provide serial communication port RS-485 or R8-232C. Transmission 9600 baud (minimum).

M. Provide 5-60 minute programmable demand interval.

2.02 Metering Transformers

A. Manufacturers:
   1. Yokogawa.
   2. Westinghouse.
   3. Crompton.

B. Current Transformers: ANSI C57.13; 5 ampere secondary Y bar or window type with single secondary winding and secondary shorting device. primary/secondary ratio as required. burden and accuracy consistent with connected metering and relay devices. 60 Hertz.

C. Potential Transformers: ANSI C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings. primary/secondary ration as required. burden and accuracy consistent with connected metering and relay devices, 60 Hertz

PART 3 – EXECUTION

3.01 Installation

A. Install in accordance with manufacturer's instructions.

3.02 Commissioning

A. Refer to ELECTRICAL COMMISSIONING requirements.

B. Verify correct readings of various values at project BEMS display.

3.03 Testing

A. Refer to 16950 - TESTING REQUIREMENTS for system testing requirements.
SECTION 16921
MECHANICAL EQUIPMENT COORDINATION

PART 1 – GENERAL
1.01 Summary
A. Power and raceways for mechanical equipment.

1.02 Related Work
A. Section 15010: MECHANICAL GENERAL PROVISIONS
B. Section 16050: BASIC MATERIALS AND METHODS
C. Section 16920: MOTOR CONTROL CENTERS
D. Section 16721: FIRE ALARM SYSTEM

1.03 Submittals
A. Manufacturer's Literature describing each product.

PART 2 – PRODUCTS
2.01 Description
A. All products are noted in other Sections of the Specifications.

PART 3 – EXECUTION
3.01 Installation
A. Electrical contractor installs 480 volt and 120 volt power to mechanical equipment. Electrical contractor provides switches and pilots for fans controlled by switches and wires them complete. Electrical contractor installs line voltage interlock wiring and control wiring to starters.
B. Mechanical contractor installs temperature control and all low-voltage conduit and wire.
C. Electrical contractor provides starters except for package units.
D. All connections shall be made in accordance with the certified and approved drawings under Section 15010, MECHANICAL GENERAL PROVISIONS.
E. Electrical contractor furnishes and connects smoke duct detectors and provides fire alarm signal wires to temperature control panels.
F. Mechanical contractor installs the smoke duct detectors in mechanical ducts complete with sampling tubes in accordance with Manufacturer's instructions.
G. Electrical contractor shall provide all equipment local disconnect switches as defined by CEC.
3.02 Tests

A. At completion of this installation, verify that all control wiring is free of shorts and all control devices are properly connected for the design function.

END OF SECTION
SECTION 16950

TESTING REQUIREMENTS

PART 1 – GENERAL

1.01 Summary

A. Tests specified in this Section are in addition to that specified in other Sections of this Specification.

B. The Contractor shall furnish the services of an independent test agency for testing of the following equipment:

1. Distribution switchboards.
2. Grounding system.
3. Circuit breakers 150 amperes and larger.
4. Instruments and instrument transformers.
5. Thermographic survey.

C. The test agency shall be the General Electric Installation, Service and Engineering Department, Electro-Test, Westinghouse Engineering Service or Power System Testing, or equal. Contractor shall furnish all necessary labor, material, etc., to the test agency to assist them in their work while on the Site. The testing of the various components and completion of any corrective work shall be performed after the equipment has been set in its final location. Verification that corrective work has been completed shall be by the test agency unless permission is received from the Owner to waive this requirement.

1.02 Applicable Codes, Standards, and References

A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:

1. National Electrical Manufacturer’s Association - NEMA.
3. Institute of Electrical and Electronic Engineers- IEEE.
6. State and local codes and ordinances.
7. Insulated Cable Engineers Association - ICEA.
8. Association of Edison Illuminating Companies - AEIC.
9. Occupational Safety and Health Administration- OSHA.
10. National Fire Protection Association - NFPA.

b. ANSI/NFPA 70B: Electrical Equipment Maintenance.

c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces.


B. All inspections and tests shall utilize the following references:

1. Project design specifications.
2. Project design drawings.
4. Manufacturer’s instruction manuals applicable to each particular apparatus.
5. Project list of equipment to be inspected and tested.

1.03 Submittals

A. Provide submittals in accordance with provisions of Section 01300, SUBMITTALS.

B. Test Report:

1. The test report shall include the following:
   a. Summary of Job.
   b. Description of equipment tested.
   c. Description of test procedure.
   d. List of test equipment and calibration date.
   e. Test results.
   f. Conclusions and recommendations.
   g. Appendix, including all field test reports.

2. The report shall be bound and its contents certified.

3. Furnish 6 copies of completed report to the Owner no later than 30 days before Project completion unless requested otherwise by the Owner.

4. In addition, the test agency, after completion of any test or tests and prior to leaving the Site, shall prepare a brief field report. Report may be typed or neatly printed listing the equipment tested, whether the test was complete and if any deficiencies were found and corrective recommendations. A copy shall be left with the Contractor and the Project superintendent for his records and copies shall be mailed within 3 days to the Owner.

5. The report shall include the following information: Contractor, Site, equipment designations phase and ground overcurrent device data, system typesetting, inspection and test results.

6. Certification of the test report.
1.04 Division of Responsibility

A. The Contractor shall perform routine insulation-resistance, continuity, equipment bolt-torque level and rotation tests, inspect for physical damage, proper connection and operation, coordinate exact motor overloads and utilize recommended cleaning methods for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.

B. The Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The Contractor shall notify the Inspector of Record (IOR) and the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. The Owner's Representative is responsible for approving a short-circuit analysis and coordination study prepared and certified by an independent testing firm or manufacturer as outlined by Section 16960, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.

E. The testing firm shall notify the Owner's Representative prior to commencement of any testing.

F. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported to the Owner's Representative in writing.

G. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

H. Safety and Precautions:
   1. Safety practices shall include, but are not limited to, the following requirements:
      a. Occupational Safety and Health Act
      c. Applicable state and local safety operating procedures.
      d. Owner's safety practices.
      e. National Fire Protection Association - NFPA 70E.
      g. All tests shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
   2. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.

PART 2 – PRODUCTS

2.01 Test Equipment

A. All test equipment necessary to conduct the testing requirements will be brought to the Site by the testing agency.

B. Care and Precautions:
1. Contractor shall be responsible for any damage to equipment or material due to improper test procedures or test apparatus handling, and shall replace or restore to original condition any damaged equipment or material.

2. Contractor shall furnish and use safety devices such as rubber gloves and blankets, protective screen, barriers and danger signs to adequately protect and warm all personnel in the Vicinity of the tests.

3. All test equipment shall be calibrated and certified traceable to the National Bureau of Standards certification date shall be no later than 6 months.

PART 3 – EXECUTION

3.01 Application

A. General:

1. Provide all materials, supplies, tools, equipment labor, and services required to perform all tests as specified in this Section.

2. Correct all deficiencies revealed by tests. Replace at Contractor's cost all materials and equipment found faulty.

3. It is the intent of these tests to assure that all electrical equipment both Contractor and Owner supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specification.

4. The test and inspections shall determine the suitability for energization.

5. The International Electrical Testing Association (NETA) guidelines are to be used for all the testing procedures and acceptance test valves of results.

6. Complete all testing prior to commissioning and final acceptance.

B. Work Included

1. Test all cable, equipment and systems listed above to assure proper installation, setting, connections, and functioning in accordance with the Drawings, Specifications, and the manufacturer's recommendations. It is the intent of this Guideline that field testing be extensive, and complete as specified, to provide positive assurance of totally correct installation and operation of equipment.

2. Furnish all necessary test equipment to satisfactorily perform all tests specified herein.

3. When conducting tests the Contractor shall:

   a. Notify the Owner and IOR at least 2 weeks prior to commencement of any testing.

   b. Conduct all tests in the presence of the Owner's Representative and IOR except when advised that his presence will not be necessary.

   c. Include all tests and inspection recommended by the equipment manufacturer whether required by these specifications or not unless specifically waived by the Owner.

   d. Maintain it written record of all tests showing date, personnel making test, equipment or material tested, tests performed, manufacturer and serial number of testing equipment and results.

4. Tests shall include, but are not limited to, the following:
a. All Wiring: Free of shorts unintentional and grounds.
b. Molded case breakers 150 amperes and larger. Time and instantaneous tripping. Physical condition, contact resistance, insulation resistance.
c. Power Circuit Breakers: Calibration to time/current curves, physical condition, contact resistance, insulation resistance.
d. Grounding system: Ground resistance (impedance), ground integrity.
e. Secondary Service Bus Ducts: Proper torque on connections, insulation resistance, physical condition.
f. Motor Controls: Proper overload heater sizes.
g. Ground Fault System: Neutral free of improper grounds and pick-Up.
h. Protective Relays: Pick-up, timing, insulation resistance, physical condition.
i. Switchboards, Panelboards etc.: Insulation resistance, physical condition.
j. Feeder Cables: Insulation resistance.
k. Motors: Proper rotation, insulation resistance.

C. Minimum Acceptable Test Results:

1. Ground System: The main ground electrode system resistance to ground no greater than 5 ohms.

2. Electrical Apparatus and System Insulation Resistance:
   a. Rating of equipment of 250 volts maximum, minimum D.C. test voltage shall be 500 volts D.C. and minimum insulation resistance shall be 25 megohms.
   b. Rating of equipment of 600 volts, minimum insulation resistance shall be 100 megohms.

3. Wire and Cables Under 600 Volts:
   a. Rating of cables of 300 volts maximum, minimum D.C. test voltage shall be 500 volts D.C. and minimum insulation resistance shall be 50 megohms.
   b. Rating of cables of 600 volts maximum, minimum D.C. test voltage shall be 1000 volts D.C. and minimum insulation resistance shall be 50 megohms.

3.02 Technical Requirements

A. Grounding Systems:

1. Tests shall include measurement of ground resistance at the following equipment and structures:
   a. All primary and secondary switchgear.
   b. All power transformer frames and neutral grounds.
   c. All secondary switchboards located within buildings.
   d. Other miscellaneous grounds selected at random in a manner to be representative of the entire installation.
e. Ground system ground rods, including those in manholes.

f. Isolated instrumentation system.

2. Ground tests shall be made on system ground rods by the "3 probe - fall of potential" method. All other ground tests may be measured to system ground by use of ground reference method.

3. Prior to full test by the test agency, the Contractor shall clarify that the equipment has been correctly installed.

4. All defective circuits showing more than 5 ohms resistance to ground shall be repaired at the Contractor’s cost.

B. Switchboard Breakers:

1. Electrical Tests:

   a. Megger test breaker. Voltage 1000 + 2x rated voltage phase to phase, phase to ground with breaker closed, cross pole breaker open.

   b. Check trip free operation.

   c. The trip devices shall be primary injection current tested as follows:

2. Long Time Delay Element: Apply a current of 3 times the LTD pickup value to each pole, recording current and times required for breaker trip. Compare recorded tripping times with the manufacturer’s time-current curves. Test values outside the manufacturer’s curves shall be called to the attention of the Owner’s Representative and IOR.

3. Short-Time Delay Element: Apply a current of 1.5 times the STD pickup value to each pole, recording current and times required for breaker to trip. Compare recorded tripping times with the manufacturer’s time-current curves. Test values outside the manufacturer’s curves shall be called to the attention of the Owner’s Representative and IOR.

4. Instantaneous Element Test by applying a rapidly increasing current, recording value which causes breaker to consistently trip instantaneously. Adjust calibration to obtain tripping values.

5. Set final solid state breaker trip settings as determined by Section 16960 and upon final approval of the study by the Owner’s Representative.

C. Digital Instruments:

1. Ammeter:

   a. Check connections from current transformer.

   b. Check ammeter function for proper operation.

2. Voltmeter:

   a. Check connections from potential transformer.

   b. Check voltmeter function for proper operation.

D. Instruments Transformers (Current and Potential Transformers):

1. Physically check polarity mark orientation on all CT’s and PT’s with three-line diagrams and manufacturer’s drawings.
2. Where CI's are used for protective relaying, the following tests shall be performed:
   a. Electrically check for correct polarity markings.
   b. High current ratio test by injection of primary currents. Current readings shall be taken at relays, meters, and instrument test blocks to verify CT ratio with connected burden.

3. Electrically check all PT polarity markings.

E. Ground Fault System:

1. All tests shall be completed before the initial energization of the service equipment.

2. The relay pickup current shall be determined within the limits of the device tolerance by primary injection of current at the C.T. and effecting amain protective device trip operation.

3. The relay timing shall be tested by injecting 150% and 300% of pickup current into the C.T. and electrically monitoring the trip time with a cycle or digital counter. The total trip time minimum breaker or switch reaction time equals the relay time. This relay time shall be compared to the manufacturer's published time.

4. The system's neutral insulation resistance shall be tested to ensure no shunt ground paths. The neutral-ground disconnect link shall be removed, neutral meggered clear and link replaced.

5. Operate the monitor (test panel) to ensure proper indication and test operation sequence.

6. Affix calibration labels to all equipment tested. Labels shall indicate date test, engineer, firm name and relay trip date as calibrated (trip time and relay setting in amperes).

7. During construction, relay pickups shall be set at minimum values. Set final ground fault system settings to the coordination study as determined by section 16050 and upon final approval of the study by the Owner's Representative.

F. Thermographic Survey:

1. Visual and Mechanical Inspection:
   a. Remove all necessary covers prior to scanning.
   b. Inspect for physical, electrical, and mechanical condition.

2. Equipment to be Scanned as follows:
   a. Medium/low voltage switchgear.
   b. Busways (600 volts).
   c. Transformers-Dry-Type (larger than 300 KVA).
   d. Main distribution switchboard.
   e. Automatic transfer/bypass switch.

3. Provide report indicating the following:
   a. Problem area (location of "hot spot").
   b. Temperature rise between "hot spot and normal or reference area.
c. Cause of heat rise.

d. Phase unbalance, if present

e. Areas scanned.

3.03 Retesting

A. Retest any equipment which does not pass initial tests, or where subsequent testing is required for acceptance as directed by the Owner's Representative. The Owner's Representative shall be the sole judge of whether retesting is necessary.

3.04 Replacement of Defective Material or Equipment

A. Any material or equipment which is found to be defective and cannot pass the tests specified in this Section shall be replaced by the Contractor at no additional cost to the Owner. The Owner's Representative shall be the sole judge of whether equipment is defective or not

B. Replacement of defective material and retesting shall be accomplished within the Contract period.

C. If the equipment or material cannot pass the second test, the Contractor shall remove the defective equipment and replace it with equal equipment which meets the requirements of the Specifications. Such replacement shall be at no additional cost to the Owner.

D. Defective equipment or material shall be removed from the Site no later than 15 days from the date of notification by the Owner or his representative.

3.05 Field Adjustment

A. Testing firm shall implement all final setting and adjustments on protective devices in accordance with the coordination study values determined by Section 16960 and as approved by the Owner's Representative.

END OF SECTION
SECTION 16970
COMMISSIONING

PART 1 – GENERAL

1.01 Summary

A. This Section describes the requirements for start-up and performance verification for Division 16 installed work, including but not limited to:

1. Normal power distribution system.
2. Standby power distribution system.
3. Fire alarm system.
4. Lighting systems.
5. Lighting control system.

1.02 References

A. Nation Electrical Testing Association (NETA).
B. American National Standard Institute (ANSI).
C. Institute of Electrical and Electronic Engineers (IEEE).
D. California Electrical Code (CEC).

1.03 Submittals

A. Comply with provisions of Section 01300· SUBMITTALS.
B. Collaborate with the General Contractor to provide a complete commissioning and training plan submittal for the electrical work.

1.04 Quality Assurance

A. Provide testing equipment and accessories that are free of defects and are certified for use.
B. Provide testing equipment with current Calibration labels.
C. Comply with commissioning procedures to ANSI and IEEE guidelines. Incorporate manufacturer's recommended commission procedures for equipment.

1.05 Coordination

A. Coordinate commissioning work with the requirements of Section 01040 - PROJECT COORDINATION and DIVISION 1 BUILDING SYSTEMS PROJECT VERIFICATION.
B. Coordinate commissioning requirements noted in other Division 16 Sections.
PART 2 – PRODUCTS
NOT USED

PART 3 – EXECUTION

3.01 Examination
A. **Verify** that equipment testing work is complete before starting functional performance of power equipment.
B. **Verify** that operational manuals are complete and been approved *by* the Architect before starting functional performance testing.
C. Inspection equipment and confirm that it is clean and *ready* for operation. All shipping tags removed, nameplates installed and equipment manuals in place.
D. See attached sample Functional Test Procedure.

3.02 Preparation
A. Provide at least 1 journeyman electrician with tools and equipment necessary to perform functional testing.
B. Provide equipment factory representative for this work when needed.
C. Provide certified testing *agency* personnel for this work when needed.
D. Provide any necessary temporary power provisions, diesel fuel, equipment and sundries to complete this work.

3.03 Power Performance Verification
A. Perform performance verification work in accordance with Functional Test Procedure and equipment manufacturer's standard procedures and verify lists, including but not limited to:
   1. Verify test readings, such as:
      a. Cable DC Hipot.
      b. Ground fault protection.
      c. Ground resistance.
      d. Frequency.
      e. Transformer heating.
      f. Circuit breaker tripping.
   2. Verify calibration of meters:
      a. kW-Hr meters.
      b. Voltmeters.
      c. Ammeters.
d. Frequency meters.
e. Circuit breakers.
f. Fuse

4. Verify readings of remote data systems.

3.04 Fire Alarm System Performance Verification

A. Perform performance verification work after alarm equipment is installed and system ready for operation.

B. Perform performance verification work in accordance to the manufacturer's standard procedures and check lists, including but not limited to:

1. Verify tests such as:
   a. Alarm db.
   b. Detectors initiating signal.
   c. Trouble light

2. Verify settings of:
   a. Smoke detectors.
   b. Heat detectors.
   c. Duct detectors

3. Verify readings of remote data, such as annunciator panel.

4. Verify operation of system modes, such:
   a. Elevator control.
   b. Sprinkler supervisory alarm.
   c. Kitchen hood extinguishing system.
   d. Door hold open/release.

5. Verify that total alarm system is performing to provide conditions as outlined in the design intent.

3.05 Lighting Control System Performance Verification

A. See Section 16920, Lighting Controls.

3.06 Checklist – Normal Power Distribution

A. Prior to functional performance test:

1. System in place. including all components indicated, and tested.
2. Connected to utility company power system on a permanent basis.
3. Wiring installed in conduits or other raceways.
4. System checked for unwanted grounds, short circuits or open circuits.
5. Ground installed as indicated, including transformers.
7. Equipment, where indicated, including transformers.
8. Equipment cleaned and shipping blocks removed.
10. Equipment labeled.
11. Boxes and nameplates meet color coding requirements.

B. Personnel to be present or assist as required to perform functional performance test:
   1. General Contractor, Mechanical Contractor, control Contractor, and Electrical Contractor, subcontractors and specialty contractors as required.
   2. Owner’s project Manager/Representative and/or Inspector of Record (I. O. R.).
   3. Owner’s maintenance staff.
   4. Architects Design Engineer(s).

C. Functional performance test: demonstrate operation of normal power distribution system per specifications including the following:
   1. Activate system by connection to utility power.
   2. Verify voltages and amperes at meters on switchgear.
   3. Verify voltages and amperes at switchgear, switchboards, motor control centers, panel/boards, transformers primary and secondary.
   4. Verify voltages and amperes at mechanical motors and other major pieces of equipment.

D. Results:
   1. If specified equipment performance is not verified, the General Contractor to have corrections made and reschedule functional performance test as soon as possible after corrective work is completed.

3.07 Checklist – Fire Alarm System

A. Prior to Functional Performance Test
   1. System in place, including all components indicated, and tested.
   2. Connected to emergency power system.
   3. Wiring is plenum rated where required.
4. Exposed areas: Wiring installed in conduit.
5. System checked for grounds or breakers.
6. System connected to elevator control system, sprinkler alarm system and air handling systems.
7. Wiring installed in conduit.
8. Cables have color coded identification tags.
9. Boxes and nameplates meet color coding requirements.
10. Verify system has been inspected and given approval by jurisdiction authority.

B. Personnel to be present or assist as required to perform Functional Performance Test:

1. General Contractor, Mechanical Contractor, Control Contractor, Fire Alarm Manufacturer's Representative, and Electrical Contractor, sub-contractors and specialty contractors as required.
2. Owner's Project Manager/Representative and/or Inspector of Record (I.O.R.).
3. Owner's maintenance staff, as desired.
4. Architect's Design Engineer(s).

C. Functional Performance Test Demonstrate operation of fire alarm system per specifications including the following:

1. Alarm initiating devices including pull stations, ceiling smoke detectors, duct smoke detectors, heat detectors, and sprinkler alarm switches.
2. Air handling unit redirect upon alarm.
3. Elevators upon alarm.
4. Verify tie-in and proper system operation with any off-site system monitoring.
5. Fire alarm system annunciator panel.
6. Alarm devices, visual and audible.
7. Central processing unit alphanumeric display and printer.
8. Verify system function upon loss of power.

D. Results:

1. If specified equipment performance is not verified, the General Contractor to have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Reports:

1. Submit reports of function performance test (item C above) to Architect.
3.08 Training

A. Coordinate with the training requirements of DIVISION 1.

B. At job completion, allot a period of not less than 40 hours for instruction of building operation and maintenance personnel in the use of all systems. Include high voltage safety training where medium voltage equipment is installed. This instruction time (40 hours) is in addition to any instruction time called out in other Division 16 Sections.

C. Instruct all personnel at the same time. Contractor responsible for coordinating factory representative arrangements.

D. Contractor responsible for training expenses incurred.

END OF SECTION
SECTION 16995
COMMISSIONING OF ELECTRICAL SYSTEMS

GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System specific commissioning of Day lighting and Lighting Control (interior and exterior).

B. Related Sections
   1. 01810 – Commissioning General Requirements
   2. Division 15

1.2 DESCRIPTION OF WORK – refer to 01810

1.3 SUBMITTALS – refer to 01810

PART 2 - PRODUCTS – REFER TO 01810

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS AND PROCEDURES – refer to 01810

3.2 Cx OF LIGHTING CONTROLS SYSTEM

A. SYSTEMS READINESS CHECKLISTS
   1. Review and Complete Systems Readiness Checklists in accordance with Section 01810 and 16995.
   2. Contractor’s Commissioning Coordinator shall verify completion of all items, sign and return the checklist to the Commissioning Authority as an indication of final completion with all installation criteria as specified in the Project Contract Documents
   3. The initial Systems Readiness Checklists are provided on the following pages of this section of the contract documents. The final checklists may be modifications of the initial checklists, and checklists may be added; modifications and additions to be made by the Commissioning Authority after equipment submittals have been accepted.
   4. A separate completed checklist shall be submitted for each system and item of equipment within the commissioning scope of work, as specified in 01810.
   5. The Systems Readiness Checklists do not represent all the contract documents for the associated equipment. Completion of the items on this checklist does not release the contractor from requirements specified elsewhere

B. SYSTEMS READINESS PLAN
   1. The Contractor shall provide a system readiness manual, which shall include the following:
      a. Systems Readiness Checklists – provided by CxA and completed by the Contractor except as noted below.
2. Startup and testing procedures and data forms, in accordance with the project specifications, for all equipment and systems within the commissioning scope of work.

3. Within 20 working days of Product Submittal approval, submit the Systems Readiness Plan with blank forms for CxA review.

4. Submit the completed readiness manual prior to functional performance testing. When it is necessary to begin functional performance testing on a system (or systems) before the readiness of other systems can be documented, it may be acceptable to provide preliminary submittals of the Systems Readiness Plan that have been completed only for the system(s) that are ready for testing.

C. FUNCTIONAL PERFORMANCE TESTING

1. The Functional Performance Test (FPT) Procedures shall be developed, performed and demonstrated in accordance with Section 01810.

2. At a minimum, the contractors and equipment suppliers listed in the FPTs Minimum Participants Table in this section of the specifications are required to participate in developing, performing and demonstrating the indicated FPTs.

3. The initial FPTs will be developed after review of the submittals. The final FPTs may be modifications of the initial FPTs, and FPTs may be added; modifications and additions to be made by the Commissioning Authority after equipment submittals have been accepted.

4. The Contractor’s Commissioning Coordinator shall coordinate the subcontractors, with the Commissioning Authority’s input, in developing, performing and demonstrating the Working FPT.

5. For the following systems, the contractor shall provide a finalized draft of the startup and testing plan for CxA review, at least two weeks prior to system testing. The CA shall witness the contractors testing plan and review the results. The contractor shall submit completed testing documentation for inclusion in the final commissioning report.
   a. Lighting and Day Lighting Controls
   b. Occupancy Sensor Controls
   c. Lighting Relay Panel Controls

6. Functional testing shall consist of the following four phases:
   a. Component testing:
      1) Component testing applies to all control input and output devices, including those provided the equipment suppliers and those provide with the Lighting Control System. Examples include but are not limited to: occupancy sensors, photo sensors, automatic switches etc.
      2) Component testing applies to lighting relay panels, occupancy and day lighting sensor controls.
      3) Component testing consists of demonstrating field I/O calibration and operation including but not limited to:
         a) Accuracy of sensors is within design range as specified.
         b) Alarmed points report correctly to operator work station.
         c) Accuracy and settings of binary switches and alarms is as specified, within design temperature range.
         d) Sensors and actuators operate smoothly in a linear relationship with the signal they receive over the full range of operation.
         e) Fail safe operation of components and controllers is as specified for loss of control signal, electric power, and network communications.
         f) All components, values and alarms are correctly mapped to operator interface station.
   b. Systems Testing; Operational Verification: After functional testing of the system components has been successfully completed, each sequence of operation and control system function shall be functionally tested, including those provided the equipment suppliers and those provide with the Lighting Control System. Each control loop shall be tested to verify stable control with the specified and appropriate responses.
c. Systems Testing – Integrated System Verification: After operational testing has successfully demonstrated that each system functions in accordance with the project documents, functional testing shall occur to verify that the interaction between the systems is as required. Each interactive function shall be functionally tested, including those provided by the equipment suppliers and those provided with the Lighting Control System.


1) After operational testing has been successfully completed, real-time performance testing shall be performed. Data shall be logged for the intervals and periods specified in the FPT procedures. Unless otherwise specified in the FPTs, test periods shall include occupied, unoccupied, weekend, and holiday schedules.

2) Analysis of the data shall demonstrate that the systems operate in accordance with the acceptance criteria specified in the FPT procedures. Verify that data demonstrates acceptable results before submitting for CA review. If acceptable results are not demonstrated, perform testing and troubleshooting and corrective action to provide resolution. Provisions for retesting, as specified in 01810 shall apply to trend log analysis.

D. FUNCTIONAL PERFORMANCE TEST (FPT) DEMONSTRATION SAMPLING

1. When an FPT applies to many similar components or systems that are not a part of a life-safety system, the contractor may demonstrate the functional performance tests (FPTs) to the Commissioning Authority (CA) as specified in Section 01810. Demonstration Sampling will apply only in accordance with 01810, and only for the components and systems listed in the accompanying Functional Performance Test (FPT) Demonstration Sampling Table.

<table>
<thead>
<tr>
<th>FPT PROCEDURE</th>
<th>SAMPLE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>To be developed in construction document design phase</td>
<td></td>
</tr>
</tbody>
</table>

E. FPTS MINIMUM PARTICIPANTS TABLE:

1. The following table lists the FPTs, and the subcontractors and suppliers that are required to participate in their development and performance as specified in 01810.

2. Further details on the table to be developed in the construction phase.

3. The key to the codes used in the minimum participants column of the table is as follows:

   Electrical Contractor = EC

<table>
<thead>
<tr>
<th>FPT PROCEDURE</th>
<th>MINIMUM PARTICIPANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC</td>
</tr>
<tr>
<td>Lighting Control System</td>
<td>EC</td>
</tr>
</tbody>
</table>
3.3 SAMPLE SYSTEM READINESS CHECKLIST

Applicable Equipment:

Instructions: Contractor shall submit a completed and signed copy of this checklist as an indication of compliance with all installation criteria specified in the Construction Documents.

Installation:
- Light fixtures and lighting controls have been fully installed.
- Proper sized breakers have been installed on each lighting circuit.
- Final wiring connections are complete.
- Wiring has been tagged with permanent labels per Construction Documents.
- Lighting fixtures, sensors and controls have been tagged with permanent labels per Construction Documents.
- There are no metal shavings inside panel enclosures.
- Junction boxes for control wiring are installed such that Class 2 wiring is not run in common with Class 1 wiring.
- Lighting levels have been measured and verified as appropriate for all zones.
- Occupancy sensor control has been adjusted and tested for every zone.
- Occupancy sensors have been located to minimize false signals or interference by obstructions.
- Ultrasonic occupancy sensors do not emit sound audible to occupants, if applicable.

Signed: _____________________________   Date: ________  Company: ________________

Control System Integration:
- Sensors and controls have been installed and verified operational.
- Lighting control timers are programmed for weekday, weekend, and holiday schedules and programming is documented for the owner if applicable.
- Occupant override time limit is set to no more than 2 hours.

Signed: _____________________________   Date: ________  Company: ________________

FPT Readiness:
- All contractor-submitted start-up and testing documentation has been completed and provided to the Commissioning Authority.
- Commissioning Authority notified of and witnessed testing per contract documents.
- Damaged factory finishes have been replaced, repaired or touched up.
- All known issues have been corrected or reported to the CxA and the systems are ready for the functional performance test phase of commissioning.
- EQUIPMENT READY FOR FUNCTIONAL TESTING – Contractor's pre-functional testing is complete; contractor has verified that functional performance testing (FPT) of the equipment and associated system demonstrates acceptable results as specified in FPT procedures.

Signed: _____________________________   Date: ________  Company: ________________
This checklist is not intended to represent all the requirements of the Construction Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: _________________________ Date: _________________________
Contractor's Commissioning Coordinator

Signed: _________________________ Date: _________________________
Commissioning Authority

Outstanding Issues: _________________________________________________________
3.4 SAMPLE FUNCTIONAL PERFORMANCE TEST

Lighting System Functional Performance Tests

A) Requirements
1) Complete this form to document testing of the lighting system.

B) Objectives
1) Verify that lighting fixtures are activated according to the schedule programmed in the Building Automation System (BAS).
2) Verify that individual lighting fixtures respond to on and off commands from local switches.
3) Verify that individual lighting fixtures activate in response to occupancy sensors.
4) Verify that lighting fixtures triggered by occupancy sensors time out appropriately.

C) Equipment Tested
1) Lighting fixtures
2) Lighting switches
3) Occupancy sensors

D) Basis of Test
1) Project specifications and drawings.
2) Control logic based on the sequences of operation as shown below.

E) Sequence of Operations
   a) <INSERT FINAL SOO HERE>

F) Minimum Participants
1) Owner’s witness
2) Controls contractor
3) Test technician
4) Commissioning Authority
G) Procedure
1) Participants sign in on the log below.
2) Record the equipment data on the next table.
3) Verify the prerequisites as shown. If any prerequisite fails, remedy the failure and verify the remedy before continuing.
4) Follow the step by step instructions.
5) Command and view all points from the BAS graphic user interface. Describe any deviation, or elaboration, on the test procedure in the Notes sections. Attach additional pages for notes if necessary. To facilitate photocopying, do not write on the backs of forms.
6) Test validation will be accomplished via trend analysis. As such, please follow the requested waiting times between certain steps to allow the system time to respond to the changes being made.
7) Recording the time of test steps is critical in allowing the tester to locate the events in the trend logs.

H) Participant Sign-In

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Initials</th>
<th>Company</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner's Witness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controls Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Technician</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning Authority</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I) Test Equipment Record
8) Watch with stopwatch function.

J) Prerequisites
9) Verify the following prerequisites. Initial: _______ Date: ___/___/____ Time: ____:
   a) System Readiness Checklists are complete, and SRC Deficiencies have been reviewed and corrected to the satisfaction of the Participants to permit meaningful execution of these Tests.
   b) Equipment to be controlled is operational.
   c) BAS System operator's graphical interface is complete for the systems involving these components.
   d) All operational changes to the sequences of operations have been completed.
10) Establish Trends for all points listed in the following table. The trends must be recording before performing the tests in the next section. Trend must run for a period of 2 weeks minimum and be recording during the completion of the remainder of the test procedures.

<table>
<thead>
<tr>
<th>Trend</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupancy Sensor Status (for each sensor)</td>
<td>2 min</td>
</tr>
<tr>
<td>Lighting Fixture Status (for each independently-controlled fixture)</td>
<td>2 min</td>
</tr>
<tr>
<td>Switch Position (for each switch)</td>
<td>2 min</td>
</tr>
</tbody>
</table>

K) Testing Procedure
1) Ensure the system is running normally before beginning the test.
2) Record the date of the test: ____________

3) Activation Test
   a) Record the start time of the test: ____________
   b) Place all lights in the occupied mode.
   c) Toggle each circuit via the wall switch – verify each circuit turns on then off then on.
   d) Record results for each circuit.
   e) Toggle each circuit via the BAS – verify each circuit turns on then off.
   f) Record results for each circuit or space.

Evaluate test .................................................................................................................................Pass / Fail

4) Sweep Test
   a) Record the start time of the test: ____________
   b) Place all lights in the occupied mode.
   c) Simulate and maintain a scheduled sweep off for the lights on each floor.
   d) Verify all non-emergency lighting is off on each floor.
   e) Record results for each circuit or space.
   f) Simulate scheduled sweep on for the lights on each floor.
   g) Verify all normal occupied mode interior lighting is on.
   h) Record results for each circuit or space.
5) **Daylighting Test**
   a) Record the start time of the test: ____________
   b) Place all lights in the occupied mode.
   c) Simulate and maintain a high ambient light level for each area.
   d) Verify all non-emergency lighting is off for each area
   e) Record results for each circuit or space.
   f) Simulate and maintain a low ambient light level for each area.
   g) Verify all normal occupied mode interior lighting is on.
   h) Record results for each circuit or space.

6) **Occupancy Sensor Test**
   a) Record the start time of the test: ____________
   b) Place all lights in the occupied mode.
   c) For each space that is programmed for sensor-based lighting activation, enter the room and verify that lighting turns on.
   d) Verify that each light turns off after the programmed timeout period.
   e) Record results for each circuit or space.
   f) Place all lights in the unoccupied mode and command sweep off.
   g) For each space that is programmed for after-hours occupancy override lighting, enter the room and verify that lighting turns on.
   h) Verify that each light turns off after the programmed timeout period.
   i) Record results for each circuit or space.

7) **Trend Review**
   After completion of the trend period collect the trend data and review it for the following:
   a) Lighting fixtures were made available daily by the BAS during occupied hours.
   b) Lighting fixtures were deactivated daily by BAS at the end of occupied hours.
c) Lighting fixtures activated when triggered by occupancy sensors.

Evaluate trends........................................................................................................................................Pass / Fail

END OF TESTING PROCEDURE

<table>
<thead>
<tr>
<th>Final Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: ____________________________ Date: ____________</td>
</tr>
<tr>
<td>□ Pass  □ Fail  Comments: ______________</td>
</tr>
</tbody>
</table>

END OF SECTION 16995
SECTION 17900
BUILDING MANAGEMENT SYSTEM GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 Description of Work

A. General: The control system shall be as indicated on the drawings and described in the specifications.

B. Use Direct Digital Control (DDC) technology to provide the functions necessary for control and monitoring of mechanical systems on this project.

C. Design the control system such that each system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.

D. Communication between the control panels and all workstations shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not need knowledge of the panel identifier or location to view or control an object.

E. The documentation is schematic in nature. Provide hardware and software necessary to implement the functions and sequences shown.

1.02 Related Work Specified Elsewhere

A. The General Conditions of the Contract, Supplementary Conditions, General Requirements and the provisions of Division 0 and Division 1 are a part of these Specifications and shall be used in conjunction with this Section as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Any reference to Division 17000 is to include all sections of Division 17000 included herein. Consult them for further instructions pertaining to this work.

B. Section 15010: Mechanical General Requirements

C. Section 15050: Basic Mechanical Materials and Methods

D. Section 17901: Building Management System - Control Panel

E. Section 17910: Building Management System – Field Devices

F. Division 16000: Electrical

1.03 Quality Assurance

A. System Installer Qualifications

1. The Installer shall be an authorized representative of the Control System Manufacturer of not less than three years.

2. The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
3. The installer shall have an office within 50 miles of the project site and provide 24-hour response in the event of a customer call.

4. Controller software, the application programming language, Building Controllers, Advanced Application Controllers, and Application Specific Controllers, shall be manufactured by one manufacture. Other products specified herein (i.e., sensors, valves, dampers, and actuators) need not be manufactured by a single manufacture.

1.04 Codes and Standards

A. Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids for the following codes:

1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.


3. Federal Communications Commission -- Part J.

4. ASHRAE / ANSI 135-2004 (BACnet)

B. All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 2 years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 10 years after completion of this contract.

1.05 System Performance

A. Performance Standards. The system shall conform to the following:

1. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.

2. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current, within the prior 60 seconds.

3. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.

4. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control to ensure stable and efficient operation of said equipment.

5. Performance: Programmable Controllers shall be able to execute DDC Proportional Integral Derivative, (PID) control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

6. Multiple Alarm Annunciation: All workstations on the network shall receive alarms within 5 seconds of each other.

7. Reporting Accuracy: Table 1 lists minimum acceptable reporting accuracy for all values reported by the specified system.
<table>
<thead>
<tr>
<th>Measured Variable</th>
<th>Reported Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space temperature</td>
<td>±1°F</td>
</tr>
<tr>
<td>Ducted air</td>
<td>±2°F</td>
</tr>
<tr>
<td>Outside air</td>
<td>±2°F</td>
</tr>
<tr>
<td>Water temperature</td>
<td>±1°F</td>
</tr>
<tr>
<td>Delta-T</td>
<td>±0.25°F</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>±5% RH</td>
</tr>
<tr>
<td>Water flow</td>
<td>±5% of full scale</td>
</tr>
<tr>
<td>Air flow (terminal)</td>
<td>±10% of reading</td>
</tr>
<tr>
<td>Air flow (measuring stations)</td>
<td>±5% of reading</td>
</tr>
<tr>
<td>Air pressure (ducts)</td>
<td>±0.1 &quot;W.G.</td>
</tr>
<tr>
<td>Air pressure (space)</td>
<td>±0.01 &quot;W.G.</td>
</tr>
<tr>
<td>Water pressure</td>
<td>±2% of full scale</td>
</tr>
<tr>
<td>Electrical Power</td>
<td>5% of reading</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>± 50 PPM</td>
</tr>
</tbody>
</table>

Note 1: (10%-100% of scale)
Note 2: For both absolute and differential pressure
Note 3: Not including utility supplied meters

1.06 Submittals

A. Provide shop drawings and manufacturers’ standard specification data sheets on all hardware and software to be provided. No work may begin on any segment of this project until submittals have been reviewed by the Architect for conformity with the plan and specifications. Six (6) copies are required. Submit shop drawings in print and electronically as .dwg or .dxf file formats.

B. Provide any additional information or data which is deemed necessary to determine compliance with specifications or which is deemed valuable in documenting the system to be installed.

C. Submit the following within 60 days of contract award:

1. A complete bill of materials of equipment to be used indicating quantity, manufacturer and model number. Bill of material to be shown on control drawing where the device is shown. The device tag to occur on system drawing and on bill of material.

2. Open Protocol Implementation documentation for every applicable device in the system as required.

3. A schedule of all control valves including the valve size, model number (including pattern and connections), flow, CV, pressure rating, and location.

4. Provide manufacturers cut sheets for major system components. Cut sheets to indicate corresponding device tag from shop drawing and to be the same tag on shop drawing bill of material. When manufacturer’s cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is being submitted to cover. Include:

   a. Building Controllers
   b. Advanced Application Controllers
   c. Application Specific Controllers
d. Auxiliary Control Devices

e. Proposed control system riser diagram showing system configuration, device locations, addresses, and cabling.

f. Detailed termination drawings showing all required field and factory terminations. Clearly label terminal numbers.

g. Sequence of operations for each system under control. Provide specific sequences for the use of the Control System being provided for this project.

h. Color prints of proposed graphics with a list of points for display.

D. Project Record Documents: Upon completion of installation submit three (3) copies of record (as-built) documents. The documents shall be submitted for review prior to final completion and include:

1. Project Record Drawings: These shall be as-built versions of the submittal shop drawings and sequences of operations. Provide one set of electronic media including CAD .DWG or .DXF drawing files.

2. Testing and Commissioning Reports and Checklists.

3. Operating and Maintenance (O & M) Manual: These shall be as built versions of the submittal product data. In addition to that required for the submittals, the O & M manual shall include:

a. Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.

b. Operator's Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.

c. Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.

d. Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

e. A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.

f. One set of electronic media containing files of all color-graphic screens created for the project.

g. A list of recommended spare parts with part numbers and supplier.

h. Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.

i. Complete original issue media for all software provided including operating systems, programming language, operator workstation software, and graphics software.

j. Licenses, Guarantee, and Warranty documents for all equipment and systems.

k. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) time between tasks, and task...
E. Training Manuals: Provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The Architect reserves the right to modify any or all of the training course outline and training materials.

1.07 Warranty

A. Warrant all work as follows:

1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after substantial completion. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. Respond to the Owner’s request for warranty service within 24 hours during customary business hours.

1.08 Ownership of Proprietary Material

A. All project specific developed hardware and software shall become the property of the Owner. These include, but are not limited to:

1. Record drawings,
2. Project database,
3. Job-specific application programming code,
4. All documentation.

1.09 System Acceptance

A. System Acceptance: The system installation shall be complete in all respects and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Architect/Engineer requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within 30 calendar days of the request. When the system has been deemed satisfactory in whole or in part by the Owner's representative, the system will be accepted for beneficial use which will start the warranty period for the commissioned portion.

B. The Contractor is required by the acceptance test to demonstrate the systems are calibrated and functioning in accordance with Contract Documents to the Architect/Engineer. The Contractor shall submit a proposed acceptance test agreement for testing each system's functionality, performance of stand alone control panel network, the sensors and actuators a minimum of three (3) weeks in advance of the test. The Architect/Engineer reserves the right to require the Contractor to test additional control devices or sequences not listed in the proposed acceptance test agreement. The Architect/Engineer will perform two (2) inspections of each system for acceptance. The first test will be a general test for acceptance. The second and final test will require those devices or sequences that previously did not perform in accordance with Contract Documents to be retested. The Architect/Engineer may also randomly choose other devices or sequences to be retested to ensure the whole BMS systems are still calibrated and functioning in accordance with Contract Documents, additional testing will be required until the control system does comply. The Architect/Engineer shall witness each of the additional tests. All the labor and travel cost associated with Architect/Engineer witnessing the additional testing shall be reimbursed by the Contractor.

C. Acceptance Criteria: After completion of 16 hours of training, the Contractor shall conduct an operational test, for 7 consecutive days, 24 hours per day, on the completely and totally installed and operational BMS to demonstrate
that each functions in accordance with the requirements of the approved test plan. Provide operators to man the system a minimum of 8 hours per day excluding weekends, for the duration of the operational test, in addition to available Owner's personnel. Demonstrate the correct operation of all monitored and controlled points, as well as the operation and capabilities of all software. The equipment shall operate at an average effectiveness level (AEL) of at least 95 percent for a 7 consecutive calendar day period, and final acceptance of the system will be made, provided the Contractor has satisfied all other requirements. In the event the required AEL is not reached during the initial 7 consecutive calendar days or the Contractor has determined that the AEL will not be achieved in the initial 7 consecutive days, the Contractor shall have 1 week to correct all faults with the BMS and begin the 7 day test from the start. Also, if any hour during the test the AEL for that hour falls below 95 percent, the Contractor shall start the test again as described above. Submit trend logs of all points required to demonstrate proper functioning of the system for the complete operational test period. The AEL is defined as follows: 

\[
AEL = \frac{(\text{Total Installed Points} - \text{Number of Failed Points}) \times 100}{\text{Total Installed Points}}
\]

1. The Contractor shall not attempt to correct any point failures unless one of the milestone software program tests require the point correction. The Contractor shall correct the failure, but must treat the point as a failed point for the remainder of the operational acceptance test.

2. Outages shall result whenever the BMS is unable to fulfill all required functions due to any malfunction of hardware or software; however, outages of the system resulting from the following cause will not be considered failure.

3. An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the BMS fulfills the requirements.

4. During the warranty period, not later than 6 months from completion of the first operational acceptance test, conduct a 10 day operational test to demonstrate that the BMS functions properly during the opposite climatic season, such as summer or winter.

### 1.10 Training

**A.** The Contractor shall provide the Owner's system operator's complete instructions for proper control of the system under all modes of operation.

B. The instruction time periods shall be approved by Owner and conducted during normal working hours, Monday through Friday at the job site. These instructions shall consist of both classroom and hands on training. Provide 12 hours of on site training. Up to four operators will be trained simultaneously during this period. Contractor shall provide 4 hours of instruction to the staff prior to project acceptance. An additional 4 hours of instruction shall be provided by the Contractor to the staff after project completion, but prior to operational acceptance testing. These 8 hours are included in the 12 hours on site training. The remaining hours shall be provided after six months of acceptance testing.

C. The Owner reserves the right to request removal of, and substitution for, any instructor who, in their opinion, does not demonstrate sufficient qualifications as an instructor.

END OF SECTION
SECTION 17901

BUILDING MANAGEMENT SYSTEM

CONTROL PANELS

PART 1 – GENERAL

1.01 Description of Work

A. The work of this section includes but is not limited to, the following:

1. Building Management System Description.
2. Building Controller/ NAE.
3. Advanced Application Controller, (AAC) / MPC
4. Application Specific Controller, (ASC)
5. Communications
6. Input / Output Interface

1.02 Related Work Specified Elsewhere

A. Section 15170: Instrumentation
B. Section 17900: Building Management Systems (BMS)

1.03 System Description

A. The new BMS in this project will be connected to the existing Johnson control BMS in this building. It is the intent of this specification to describe these systems and their performance. Native BACnet is the basis of design. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a “Native” BACnet internetwork. “Native” in this context shall mean that BACnet is used as the internal data communications protocol within all BMS devices. And that translators, or “gateways,” for converting proprietary data communications protocols to BACnet communications shall be internal to the BMS manufacturer’s devices, shall be manufactured by or under license to the BMS manufacture, and shall provide BACnet-based interoperability of all devices as specified herein. Functionality of any “gateways” provided to achieve this interoperability will be the responsibility of the BMS manufacturer (except where gateways are furnished as part of the equipment: e.g. chillers). Where “gateways” are utilized, the BMS manufacturer shall provide all firmware upgrades as necessary to achieve the specified level of interoperability. Controller shall conform to ASHRAE/ANSI Standard 135-2004, BACnet. The system shall be comprised of: BACnet Building Controller(s), BACnet Advanced Application Controller(s), BACnet Application Specific Controller(s) BACnet Smart Actuator(s) and BACnet Smart Sensor as defined in ASHRAE/ANSI Standard 135-2004.

PART 2 – PRODUCTS

2.01 Acceptable Systems Are

A. Manufacturer – Contractor
   Johnson Controls – JCI or CPC Technologies

   Product Line
   Network Automation Engine with Metasys
   Extended Architecture
B. Control System Contractor(s) will provide all necessary information and resources to provide a complete and working system as described herein. When multiple manufacturers are involved both parties will provide all necessary resources. The engineer and owner reserve the right to direct the contractor(s) at no additional contractor charge to the owner, to perform all necessary engineering, programming, installation and provide hardware and or software in order to achieve the required system interoperability and performance.

C. All supplied systems shall rely exclusively on Bacnet protocol.

2.02 Building Controllers/JCI NAE

A. Provide Building Controllers to provide the performance specified in Section 17900. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global strategies described in System software section. Building Controllers shall conform to BACnet Building Controller (B-BC) device profile as specified in ASHRAE/ANSI 135-2004, BACnet Annex L.

2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.

3. The controller shall provide a communications port for connection of the POWS using Point to Point BACnet physical/data link layer protocol or a connection to the inter-network.

4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

5. Controllers that perform scheduling shall have a real time clock.

6. Data shall be shared between networked Building Controllers.

7. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
   
   Assume a predetermined failure mode.

   Generate an alarm notification.

8. BACnet. The Building Controller shall use the Services as defined in these BIBBS:
9.|
<table>
<thead>
<tr>
<th>Data Sharing</th>
<th>Alarm &amp; Event</th>
<th>Scheduling</th>
<th>Trending</th>
<th>Device &amp; Network Mgmt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS-RP-A,B</td>
<td>AE-N-B</td>
<td>SCHED-B</td>
<td>T-VMT-B</td>
<td>DM-DDB-A,B</td>
</tr>
<tr>
<td>DS-RPM-A,B</td>
<td>AE-ACK-B</td>
<td>T-ATR-B</td>
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<td>DM-DOB-A,B</td>
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<tr>
<td>DS-WP-A,B</td>
<td>AE-ASUM-B</td>
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<td>DM-DCC-B</td>
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<tr>
<td>DS-WPM-B</td>
<td>AE-ESUM-B</td>
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<td>DM-TS-B</td>
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<tr>
<td>DS-COVU-A,B</td>
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<td>DM-UTC-B</td>
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<td>DM-BR-B</td>
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<td>NM-CE-A</td>
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</tbody>
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B. Communications. Each Building Controller shall reside on a BACnet inter-network using the ISO 8802-3 (Ethernet) Physical/Data Link layer protocol. Each Building Controller shall also perform routing to a network of Advanced Application and Application Specific Controllers.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at 32 F to 120 F.

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.

2.03 Advanced Application Controllers/JCI Ionworks Based MPC

A. Provide Advanced Application Controllers to provide the performance specified in Section 17900 of this division. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Advanced Application Controllers to manage the local strategies described in System software section. Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing or conform to LonWorks certified hardware profiles. The Advanced Application Controllers shall have the following functionality for data sharing. Ability to provide the values of any of its BACnet objects upon request. Ability to allow modification of some or all of its BACnet objects by another device. Generation of limited alarm and event notifications and ability to direct them to recipients. The Advanced Application Controller shall have the following functionality for alarm and event management. Tracking acknowledgements of alarms for human operators. Adjustment of alarm parameters. The Advanced Application Controller shall have the following functionality for device and network management. Ability to respond to queries about its status. Able to respond to requests for information about any of its objects and the ability to respond to communication control. Ability to synchronize its internal clock upon request. Ability to perform reinitialization upon request.

2. The Controller shall have sufficient memory to support its operating system, database, and programming requirements.

3. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central
4. The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

- Assume a predetermined failure mode.
- Generate an alarm notification.

5. Advanced Application Controllers shall support the following BACnet Interoperability Building Blocks (BIBBs):

<table>
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<tr>
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<td>DM-RD-B</td>
</tr>
</tbody>
</table>

B. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controller used in conditioned ambient shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 32 F to 120 F.

2. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at 40 F to 158 F.

C. A local operator interface shall be provided at building locations where specified in the sequence of operations or point list. The operator interface shall be provided for interrogating and editing data. A system security password shall be available to prevent unauthorized use of the keypad and display.

D. Serviceability. Provide diagnostic LEDs for power, communications, and processor. All low voltage wiring connections shall be made such that the controller electronics can be removed and/or replaced without disconnection of field termination wiring.

E. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

2.04 Application Specific Controllers/JCI IONWORKS Based ASC

A. Application specific controllers (ASC) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user programmable, but are customized for operation within the confines of the equipment they are designed to serve. Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing, or conform to LonWorks Certified hardware conventions.

1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

2. Each ASC will contain sufficient I/O capacity to control the target system.

3. Application Specific Controllers shall support the following BACnet Interoperability Building Blocks (BIBBs):
B. Environment. The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at 40 F to 150 F.

2. Controller used in conditioned ambient shall be mounted in NEMA 1 type rated enclosures. Controllers located where not to be disturbed by building activity (such as above ceiling grid), may be provided with plenum-rated enclosures and non-enclosed wiring connections for plenum cabling. All controllers shall be rated for operation at 32 F to 120 F.

C. Serviceability. Provide diagnostic LEDs for power and communications. All wiring connections shall be clearly labeled and made to be field removable.

D. Memory. The Application Specific Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.

E. Immunity to Power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.

F. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.

2.05 Communications

A. A. This project shall comprise a network utilizing BACnet for communications between Building Controllers and OWS.

B. B. Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined earlier in this section.

C. The controls Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network.

D. All Building Controllers shall have a communications port for connections with the operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node for connection to the Ethernet network.

E. Communications services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the internetwork. Value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller’s database. An operator/installer shall not be required to set up any communications services to perform internetwork value passing.
F. The time clocks in all controllers shall be automatically synchronized daily.

2.06 Input/Output Interface

A. Hard-wired inputs and outputs may tie into the system through Building, Advanced, or Application Specific Controllers.

B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices.

D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.

F. Binary outputs shall provide for on/off operation. Outputs shall be selectable for either normally open or normally closed operation. Provide outputs with local override switch for each output.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Provide outputs with local override switch for each output.

PART 3 – EXECUTION

3.01 Section Includes

A. Examination

B. General Workmanship

C. Wiring

D. Actuators

E. Warning Labels

F. Identification of Hardware and Wiring

G. Controllers

H. Programming

I. Cleaning

J. Protection

K. Training

L. Field Quality Control
M. Acceptance

3.02 Examination

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

B. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.03 General Workmanship

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

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

C. Install all equipment in readily accessible location as defined by chapter 1, article 100, part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

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

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

3.04 Wiring

A. A. All control and interlock wiring shall comply with the national and local electrical codes and Division 16 of these specifications. Where the requirements of this section differ with those in Division 16, the requirements of this section shall take precedence.

B. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

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

2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

C. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

D. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 5 ft intervals or more often to achieve a neat and workmanlike result.

E. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

F. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control
System Contractor shall provide step down transformers.

G. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

H. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.

I. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.

J. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

K. Adhere to Division 16 requirements for installation of raceway.

L. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

M. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.05 Warning Lables

A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

| CAUTION |
| This equipment is operating under automatic control and may start at any time without warning. |

3.06 Identification Hardware and Wiring

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

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

C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.07 Controllers

A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.

3.08 Programming

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

B. Naming: System point names shall be modular in design, allowing easy operator interface without the use of a
C. Software Programming

1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. Operators’ Interface

1. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third party software installation and integration required for successful operation of the operator interface.

2. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 16 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.

E. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 16 hours on-site with the Owner and his representatives and the Operators Workstation Network contractor for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on-line operation.

3.09 Cleaning

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

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

3.10 Protection

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be able for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.11 Field Quality Control

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.12 Commissioning System Start-Up

A. Point to Point Checkout: Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the Owner or Owner's representative.

B. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the Owner or Owner's Representative by the completion of the project.

C. System Testing

1. All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all tests results and attach to the Test Results Sheet.

2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations and printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the Owner.

3. Perform an operation test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the Owner.

4. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION
SECTION 17910

BUILDING MANAGEMENT SYSTEMS FIELD DEVICES

PART 1 – GENERAL

1.01 Description of Work

A. General: The control system field devices shall include but not limited to the following:
   1. Sensors
   2. Thermostats
   3. Switches
   4. Relays
   5. Actuators
   6. Valves
   7. Dampers

B. Refer to Section 17901 for overall system accuracy.

C. Refer to Section 17900 for general requirements.

PART 2 – PRODUCTS

2.01 Field Quality Control

A. Temperature Sensors
   1. Temperature sensors shall be Resistance Temperature Device (RTD) or Thermistor.
   2. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5m [5 feet] in length.
   3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
   4. Space sensors shall be equipped with set-point adjustment for private spaces override switch, display, and/or communication port as shown on the drawings. The public spaces will have no set-point adjustment nor override switch.
   5. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1 C [0.2 F].

B. Humidity Sensors
   1. Duct and room sensors shall have a sensing range of 20% to 80% with accuracy of ±5% R.H.
   2. Duct sensors shall be provided with a sampling chamber.
   3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% R.H. It shall be suitable
for ambient conditions of -40 C to 75 C [-40 F to 170 F].

4. Humidity sensor's drift shall not exceed 1% of full scale per year.

C. Static Pressure Sensors

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.

4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

5. For underfloor and building pressure sensors, provide 0.5% accurate non-switch selectable type, with a range of 0-0.1" WG. Setra Model 264, or equal.

6. For air highways provide 0.5% accurate non-switch selectable type with a range of 0-0.5" WG. Setra Model 264, or equal.

D. Low Limit Thermostats

1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section.

2. Low limit shall be manual reset only.

E. CO2 Sensors

1. Indoor air quality sensors shall measure total percentage CO₂ in PPM. Sensors shall be duct or space mounted.

2. Range 0-2000 ppm

3. Output Field Selectable

4. Technology Non-dispersive infrared

5. Accuracy + 75 ppm

6. Repeatability + 20 ppm

7. Mounting Wall

8. Display LCD on unit

9. Available Manufacture/Model Veris/C series

F. Flow Switches

1. Flow-proving switches shall be either paddle or differential pressure type, as shown.
2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 Type enclosure unless otherwise specified.

3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.

4. Current sensing relays may be used for flow sensing or terminal devices.

G. Relays
   1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
   2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

H. Transformers and Power Supplies
   1. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
   2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.
   3. Unit shall operate between 0 C and 50 C.
   4. Unit shall be UL recognized.

I. Current Switches
   1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

J. Electronic Damper / Valve Actuators
   1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
   2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
   3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
   4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.
   5. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not required more than 11 VA.
   6. All non-spring return actuators shall have an external manual gear release to allow manual
positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

7. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

8. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

9. Actuators shall be Underwriters Laboratories Standard 873 listed.

10. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

11. For damper Ruskin or approved equal and for valves Belimo or approved equal.

K. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.

2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
   a. Water Valves:
      (1) Two-way: 150% of total system (pump) head.
      (2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
   b. Steam Valves: 150% of operating (inlet) pressure.

3. Water Valves:
   a. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
   b. Sizing Criteria:
      (1) Two-position service: Line size.
      (2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or [5] psi, whichever is greater.
      (3) Three-way Modulating Service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), [5] psi maximum.
      (4) Valves 1/2” through 2” shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball.
      (5) 2-1/2” valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.
   c. Water valves shall fail normally open or closed as scheduled on plans or as follows:
(1) Heating coils in air handlers - normally open.

(2) Other applications - as scheduled or as required by sequence of operation.

d. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

4. Belimo or approved equal.

L. Local Control Panels

1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with [hinged door], key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.

2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control termination's for field connection shall be individually identified per control drawings.

3. Provide on/off power switch with over-current protection to each local panel.

PART 3 – EXECUTION

3.01 Section Includes

A. Examination
B. General Workmanship
C. Wiring and conduit
D. Installation of Sensors
E. Flow Switch Installation
F. Actuators
G. Warning Labels
H. Identification of Hardware and Wiring
I. Cleaning
J. Protection
K. Field Quality Control
L. Check-out, Start-up, and Testing
M. Acceptance

3.02 Examination

A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work
B. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.03 General Workmanship

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

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

C. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

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

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

3.04 Wiring

A. All control and interlock wiring shall comply with the national and local electrical codes and Division 16 of these specifications. Where the requirements of this section differ with those in Division 16, the requirements of this section shall take precedence.

B. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

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

2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

C. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

D. Where class 2 wiring is run exposed, wiring shall be run in conduit and parallel along a surface or perpendicular to it.

E. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

F. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.

G. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

H. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
I. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.

J. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

K. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

L. Adhere to Division 16 requirements for installation of raceway.

M. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

N. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.05 Installation of Sensors

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequate for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Install duct static pressure tap with tube end facing directly down-stream of air flow.

F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

G. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.

H. Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.

I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

3.06 Flow Switch Installation

A. Install using a thread-o-let in steel pipe. In copper pipe use C x C x F Tee, no pipe extensions or substitutions allowed.

B. Mount a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream or 2 feet which ever is greater, from fittings and other obstructions.

C. Install in accordance with manufacturers’ instructions.

D. Assure correct flow direction and alignment.
E. Mount in horizontal piping - flow switch on top of the pipe.
3.07 Installation of Actuators

A. Mount and link control damper actuators per manufacturer's instructions.

B. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

D. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

3.08 WARNING LABELS

A. Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

**CAUTION**
This equipment is operating under automatic control and may start at any time without warning.

3.09 Identification of Hardware and Wiring

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

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

C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.10 Controllers

A. Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of [15%] spare I/O point capacity for each point type found at each location. If input points are not universal, [15%] of each type is required. If outputs are not universal, [15%] of each type is required. A minimum of one spare is required for each type of point used.

C. Future use of spare capacity shall require providing the field device, field wiring, points database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.

3.11 Programming

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

B. **Point Naming:** System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. **Software Programming**

1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

### 3.12 Installation of Refrigerant Monitoring System

A. Install ¼” O.D. tubing to each refrigerant sensor, monitored zone. The tubing shall be refrigerant-grade copper, ¼” O.D. seamless Type ACR (hard or annealed) complying with ASTM-B280 or seamless Type K, L, or M (drawn or annealed in accordance with ASTM-B88. Tubing shall be field-assembled with compression fittings. Soldered or brazed connections are not acceptable. For most refrigerants, terminate sample tube 12”–18” above the floor. For ammonia refrigerant, use stainless steel or aluminum tubing, terminating 6”–12” from the ceiling. Install in accordance with the latest ASHRAE standards and local building codes. Provide support at less than six-foot intervals and at all bends. Provide 2 refrigerant sensors per chiller, mounted at each end of the chillers.

### 3.13 Cleaning

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dust, dirt and debris, etc.

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

### 3.14 Protection

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

### 3.15 Field Quality Control

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

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.
3.16 Acceptance

A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner’s representative. Such tests shall then be performed as part of the warranty.

END OF SECTION
SECTION 17920

BUILDING MANAGEMENT SYSTEMS SEQUENCE OF OPERATIONS

PART 1 – GENERAL

1.01 Description of Work

A. General: This describes the sequence of operations for all of the equipment listed in this section. Generally the sequence of operations addresses normal operation and failure recovery modes of the equipment. The following is a list of operational conventions that apply to and are to be adhered to in the sequence of operations:

1. Setpoints: All control loops are to have on-screen adjustable setpoints. Setpoint restrictions are to be a function of system passwords.

2. Alarms: All analog points to have high and low limits and warning limits. Binary points, alarm monitoring points to alarm on change of status. Status points to alarm when status does not match command. All alarms to require acknowledgment at OWS. Provide alarm escalation until alarm is acknowledged.

3. Trend logs: Configure the system to trend all analog input points.

4. Schedule: All major equipment to be scheduled unless otherwise noted. See Section 17901.

5. Major equipment staggered start: Refer to Section 17901.

6. Redundant / Stand by equipment: Provide lead / lag failure recovery and alarm with totalization rotation for all systems that are configured with redundant equipment.

PART 2 – PRODUCTS

2.01 The sequence of operation provided shall reside within the overall system database. The system will execute sequences using hardware described herewithin.

PART 3 – EXECUTION

3.01 Air Handling Units – VAV with Cooling Only VAV Air Handling Unit(s) with Ventilation Rest and Static Pressure Optimization

A. Economizer Control

1. The economizer shall be enabled whenever:

   a. Outside air temperature is less than 75°F.
   b. AND the outside air temperature is less than the return air temperature.
   c. AND the fan status is on.

2. When the Outdoor Air temperature is less than the supply air temperature setpoint, the outdoor air damper and return air damper will modulate, as appropriate, between the adjustable minimum position and full open to maintain the Discharge Air Temperature (62°F).

3. The economizer shall close to 0% (outside air and exhaust dampers shall be closed and return air damper shall be open) whenever:
a. Supply fan or return fan are off
b. OR mixed air temperature is less than 40°F (1).
c. OR on loss of fan status.
d. OR the Discharge Air Temperature Sensor has failed
e. OR the AHU is in the Morning Warm-up or Cool-down mode
f. OR the freezestat is on.

4. The Outdoor Air Damper will be set to its adjustable minimum position if the Economizer function is disabled. Maintain minimum outside air by modulating the minimum outside air damper to maintain setpoint outdoor air quantity. When the Economizer is commanded to minimum position, the outside air dampers shall remain at minimum position.

5. Minimum outside air damper positions shall be determined by TAB contractor at maximum and minimum supply quantities on VAV systems (one at minimum expected fan speed and one at design fan speed), and a characteristic provided to the control contractor.

6. Alarms shall be provided as follows:
   a. High Mixed Air Temp: If the mixed air temperature is 5°F greater than setpoint.
   b. Low Mixed Air Temp: If the mixed air temperature is 5°F less than setpoint.

B. Occupied Cooling Mode

1. When the AHU is in the Occupied Cooling Mode, the Supply Fan will operate continuously, the variable frequency drive will modulate to maintain the Duct Static Pressure, and the Cooling Valve and Economizer Dampers will modulate in sequence to maintain the cooling Discharge Air Temperature (62°F). The outdoor airflow shall not be less than the required minimum.

C. Unoccupied Mode

1. When the AHU is in the Unoccupied Mode, the Supply Fan will be off, the variable frequency drive, Outdoor Air Damper, and Cooling Valve will be closed.

D. Night Setback (NSB) / Morning Warm-Up Heating Mode (MWU)

1. When the AHU is in the Night Setback / Morning Warm-up Heating Mode, the Supply Fan will operate continuously, the variable frequency drive will modulate to maintain the Duct Static Pressure, the Outdoor Air Damper and Cooling Valve will be closed, the Return Air Damper will be fully open. All VAV Terminal Units will enable local heat and operate in their VAV heating mode until the NSB/MWU criteria is satisfied and the AHU returns to the occupied or unoccupied mode.

2. The Supply Fan will operate continuously whenever the AHU is in either Occupied Cooling Mode or the Night Setback / Morning Warm-up Heating Mode. The Supply Fan will be OFF whenever the AHU is in the Unoccupied Mode, the Stop / Auto interlock is open, the Mixed Air Low Limit is tripped, or the Supply Fan Status indicates a failure (after a two minute delay). The Low Limit and the Fan Failure require a manual reset.

E. Frequency Inverter Control

1. When the Supply Fan is ON, the variable frequency drive will slowly ramp (adjustable) up and
modulate to maintain the proper Discharge Duct Static Pressure Setpoint. Determination of the Discharge Duct Static Pressure Setpoint will be per the Discharge Duct Static Pressure Setpoint section of the AHU System Level Operation section of this specification. The variable frequency drive will return to zero hertz the Supply Fan is off or the Duct Static Pressure Sensor fails. A manual reset Mixed Air Low Limit will turn the Supply Fan OFF if any 12 inches of its sensing element is below its setpoint.

F. Cooling Valve Control

1. The Cooling Valve will modulate to maintain the Discharge Air Temperature at the Discharge Cooling Setpoint (62°F). If the Economizer function is enabled and the Outdoor Air Damper is not fully opened, the Cooling Valve will be closed. The Cooling Valve will be closed if the Supply Fan is off, or the Discharge Air Sensor has failed. If communication with the BMS is lost, the AHU uses its default setpoints and operates in the Occupied Cooling mode. The Economizer function is enabled based on the AHU Outdoor Air Temperature Sensor. The last known Minimum Required Outdoor Airflow Setpoint will be maintained.

G. Discharge Duct Static Pressure Setpoint

1. The discharge duct static pressure shall be sensed directly at the locations shown on the drawings and the fan VFD modulated to maintain setpoint. Provide high and low duct static alarms to the OWS at (0.1") above and below the duct static set point.

3.02 Underfloor Fan Powered Box.

A. As the space temperature rises above the cooling setpoint, the underfloor fan powered box shall modulate to its maximum CFM. As the space temperature falls below cooling setpoint, the underfloor fan powered box shall modulate to its minimum cooling CFM. Upon a further decrease in space temperature, the heating hot water valve shall modulate to maintain the space heating setpoint. If the space heating setpoint could not be maintained by modulating the heating hot water control valve, then the fan will modulate to the maximum heating set point shown on M5.01 to maintain the space heating setpoint.

B. Unoccupied Cycle

C. During the unoccupied cycle, cycle the fan and heat to maintain a reduced space temperature.

3.03 Underfloor Convector – Zone Damper and Hot Water Coil Assembly

A. Modulate zone damper and zone heating coil valve(s) in order to maintain space temperature. As the zone requires cooling, the damper will modulate open and the convector valve will be closed. As the zone requires heating, the damper will modulate close down to the minimum position (20% of the design air flow). As more heating is required, the heating valve will modulate open and then the damper will open to the maximum heating position (50% of the design air flow). During occupied mode zone damper not to close less than minimum position. Space setpoint (75°F in summer and 70°F in winter) is adjustable from BMS. Provide high and low space temperature alarms to the OWS (80°F/65°F).

3.04 Existing Atrium Exhaust Fan

A. Maintain the existing sequence of operation, which is: Stage and modulate AEF-1 and 4 in order to maintain building static pressure. If both AEF-1 and 4 are on and operating a 100% speed then stage on AEF-2 and AEF-3. In the smoke purge mode all of the atrium exhaust fans are to operate at full speed. Smoke purge is entirely a function of the Fire Alarm Control System. Smoke purge system to override all functions of the BMS. Assist Fire Alarm trade in AEF integration for normal and smoke purge modes of operation.

3.05 Smoke Control Mode

A. In the event of smoke detection in the atrium area, a signal from the smoke control panel
should be sent to the Building management system to shut down the following new units (The existing units are shown below for information only. The work for the existing units has already been done):

1. Existing EF-2-1
2. Existing EF-R-1
3. Existing FPB-O-1-5
4. Existing FPB-O-1-6
5. Existing FPB-O-1-7
6. Existing FPB-O-1-8
7. Existing FPB-O-10
8. Existing FPB-O-11
9. Existing FPB-O-12
10. Existing FPB-2-3-1
11. Existing FPB-2-3-2
12. Existing FPB-2-3-3
13. Existing FPB-2-3-4
14. Existing FPB-2-3-5
15. Existing FPB-O-1-23
16. Existing FPB-O-1-24
17. Existing FPB-O-1-30
18. Existing FPB-O-1-1
19. Existing FPB-O-1-4
20. Existing FPB-S-2A-1
22. Existing FPB-S-2A-3
23. Existing FPB-S-2B-1
24. Existing FPB-O-1-28
25. Existing FPB-O-2-1
26. Existing FPB-S-3B-3
27. Existing FPB-S-3B-4
28. Existing FPB-S-3B-5
29. Existing FPB-S-3A-1
30. Existing SF-S-3A
31. Existing SF-S-3B
32. Existing FCU-3-1
33. New FPB-S-3A-2
34. New FPB-S-3A-3
35. New FPB-S-3A-4
36. New FPB-S-3A-5
37. New FPB-S-3B-1
38. New FPB-S-3B-2
39. New FPB-S-3B-6
40. New FPB-S-3B-7
41. New FPB-S-3B-8
42. New FPB-S-3B-9
43. New FPB-S-3B-10

B. In addition to the above, the outside air dampers in the following units should be closed (this is for information only. The work for the existing units has already been done).

1. Existing FCU-1-1
2. Existing FCU-1-2
3. Existing FCU-1-3
4. Existing FCU-1-5

C. In the event of smoke detection in the non-atrium area, a signal from the smoke control panel should be sent to the Building management system to shut down the following units (This is for information only. The work for the existing units has already been done):

1. Existing FCU-1-4
2. Existing FCU-1-9
3. Existing FPB-O-1-2
4. Existing EF-R-1
5. Existing REF-R-1
6. Existing AHU-O-1

END OF SECTION