
Pima Community College PCC West Lab Building F Renovation

2202 W Anklam Rd, Tucson, AZ 85745

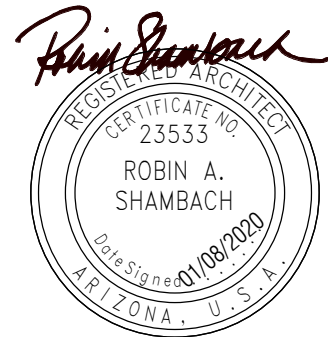
BWS Project Number: 1931.000

100% CONSTRUCTION DOCUMENTS 01/08/2020

bws | ARCHITECTS

BURNS WALD-HOPKINS SHAMBACH ARCHITECTS

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EXPIRES 06/30/2022

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PROJECT MANUAL

Pima Community College
West Campus Science Labs

CONSTRUCTION DOCUMENTS

January 8, 2021

Division 0 – Bidding Requirements – By Owner

Division 1 – General Requirements - By Owner

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January 11, 2021

**SPECIFICATIONS FOR
PIMA COUNTY COMMUNITY COLLEGE DISTRICT**

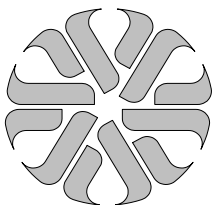
**West Campus
Science Lab Renovations
333 West Anklam Rd
TUCSON, AZ**

VOLUME 1

Facilities Planning Project 99600

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Pima County Community College District



**Facilities Operations & Construction
6680 South Country Club Road
Tucson, AZ 85709-1810**

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010000 DIVISION I - GENERAL REQUIREMENTS

SECTION

011100 SUMMARY OF THE WORK

011100.01 GENERAL:

- A. Requirements of "Instructions to Bidders" become a part of this work.
- B. The scope of this contract consists of all supervision, labor, materials, equipment, appliances, transportation, tools, permits, fees, taxes and incidentals necessary to perform all operations required to install, alter, construct and complete, all in accordance with these specifications and the applicable drawings and documents, and work reasonably inferable from the specifications and drawings, and subject to the terms and conditions of the contract.

PROJECT SCOPE: Renovation of West Campus Building F first floor and second floor for the demolition and new construction of Science Labs. The scope of work includes; new metal stud partitions, electrical, HVAC, ceiling and the science lab casework and fume hoods, per the Construction Documents.

C. Contract Time:

Anticipated Notice of Intent to Award Contract:	February 15, 2021
Anticipated Date of Notice to Proceed:	February 19, 2021
Start Construction:	March 1, 2021
Substantial Completion:	October 15, 2021
Final Completion:	November 23, 2021

If the Contractor is delayed at any time in the progress of the Work by an act or neglect of the Owner or Architect/Engineer, or of an employee of either, which the Architect/Engineer determines justifies relief, then Contract Time shall be extended by Change Order for such reasonable time as the Architect may determine.

- 1. An extension of time shall be the Contractor's sole remedy for delay. The Contractor expressly agrees not to make, and hereby waives any claim for damages against the Owner on account of any delay, obstruction, or hindrance for any cause whatsoever, and agrees that the Contractor's sole right and remedy in the case of delay shall be an extension of the time fixed for completion of the contract.
 - 2. Contract Time shall not be adjusted unless a change affects the critical path of the Work.
- D. Warranty: If, within two years after the date of Substantial completion of the work, any of the work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of written notice from the Owner. See also Section 01 78 36.
 - E. Liquidated Damages: See also Contract Article VI, Paragraph 8 "Special Conditions of the Contract".

1. If the Contractor neglects, fails or refuses to substantially complete the Work within the Contract Time, or any extension granted by Change Order, then the Contractor shall, as part consideration for the award of this contract, pay to the Owner a sum of not less than one thousand dollars (\$1000.00) per calendar day, not as a penalty, but as liquidated damages for such breach of contract, for each and every calendar day that the Contractor fails to substantially complete the work.
2. Early Completion Bonus: If the Contractor completes the work prior to the expiration of the Contract Time, the Contractor shall be paid an Early Completion Bonus at the rate of one thousand dollars (\$1000.00) for each calendar day the work is Substantially Complete in advance of the expiration of the Contract Time up to a maximum of ten thousand dollars (\$10,000.00). For purposes of the Early Completion Bonus, the Contract Time shall not be extended or changed for any reason.

F. COVID SAFETY PROTOCOLS: See Section 015000 – Temporary Facilities and Controls.

011100.02 DEFINITIONS:

- A. The term "Contractor" means the person or organization awarded the contract to complete work specified herein, and shall be a General Contractor registered and licensed by the State of Arizona, who has successfully completed a minimum of three comparable projects and can provide references for those projects.
- B. The term "Owner" as used herein means Pima County Community College District of the State of Arizona. The Owner's Representative is the Director of Facilities Operations & Construction, or his designee, and shall act on behalf of the Owner. Communication is not received unless directed to the attention of the Owner's Representative.
- C. The term "Architect/Engineer" as used herein means Architect/Engineer of Record – BWS Architects.

011100.03 INTENT OF DOCUMENTS:

- A. Drawings and Specifications are cooperative and supplementary. Portions of the work which can be best illustrated by drawings may not be included in specifications, and portions best described by specifications may not be depicted on the drawings. The Intent of the Bid Documents is to include labor, materials and services necessary for proper completion of this project.
- B. Completeness and correctness of Bid Documents shall be verified before execution by Contractor who shall notify the Architect of any errors, inconsistencies or omissions within ten (10) days. The Contractor shall be liable to the Owner or the Architect for any damages resulting from any errors, inconsistencies or omissions and knowingly failed to report it to the Architect. If the Contractor performs any construction activity knowing it involves a recognized error, inconsistency or omission in the Contract Documents without such notice to the Architect, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.
- C. Where drawings and specifications appear to conflict, specifications shall govern. Detail drawings have priority over other drawings and large scale plans have priority over small scale plans. Discrepancy in figures, drawings or specifications shall be promptly submitted to the Architect, who shall promptly make a determination in writing.

011100.04 DETAIL DRAWING INTERPRETATION:

Before doing any work or ordering any materials, Contractor shall verify measurements of existing and new work and be responsible for their correctness. Differences which may be found shall be submitted to the Architect for consideration before proceeding with the work. No extra compensation will be allowed because of differences between actual dimensions and those indicated on working drawings. The Contractor will be responsible for the locations and elevations of all the construction indicated by the construction documents.

011100.05 PROTECTION OF ADJACENT PROPERTY:

- A. Contractor is responsible for preservation of public and private property on the surface or underground, along and adjacent to the work, and shall conduct his operations so as to ensure the prevention of injury or damage thereto.
- B. Whenever direct or indirect damage or injury is done to public or private property by or on account of acts, omissions, neglect or misconduct in the execution of the work, or in consequence of non-execution thereof on the part of the Contractor, such property shall be restored by Contractor at his expense, to a condition equal to that existing before such damage or injury was done, by repairing, rebuilding or otherwise restoring same, or the contractor shall make good such damage or injury in an acceptable manner to the Owner.

END OF SECTION

SECTION 012100 - ALLOWANCES

PART 1 - GENERAL

012100.01 RELATED DOCUMENTS

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

012100.02 SUMMARY

- B. This Section includes administrative and procedural requirements governing allowances.
 - 1. Certain materials and equipment are specified in the Contract Documents by allowances. In some cases, these allowances include installation. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.
- C. Types of allowances include the following: NA

012100.03 SELECTION AND PURCHASE

- D. At the earliest practical date after award of the Contract, advise Architect/Engineer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- E. At Architect/Engineer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- F. Purchase products and systems selected by Architect/Engineer from the designated supplier.

012100.04 SUBMITTALS

- G. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.

- H. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

012100.05 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

012100.06 PREPARATION

- B. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

SCHEDULE OF ALLOWANCES - NA

END OF SECTION 012100

12300.00 ALTERNATES

PART 4 - GENERAL

4.1 RELATED DOCUMENTS

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

4.2 DEFINITION

- A. An Alternate is an amount proposed by Bidders and stated on the Bid Form for certain construction activities defined in the Bidding Requirements that may be added to or deducted from Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems or installation methods described in Contract Documents.

4.3 COORDINATION

- A. Coordinate related Work and modify or adjust adjacent work as necessary to ensure that Work affected by each accepted Alternate is complete and fully integrated into the project. Include as part of each Alternate, miscellaneous devices, accessory objects and similar items incidental to

or required for a complete installation which are reasonably inferable from the specifications and drawings describing the Alternate.

4.4 BID

A. Indicate the amount of each alternate separately on the bid form. Indicate if the alternate amount is to be added to the base bid or deducted from the base bid. The alternate amount must include all costs related to the alternate such as, but not limited to, cost to coordinate related Work, subcontractor costs, taxes, and cost of bond.

4.5 NOTIFICATION

A. Immediately following the award of the Contract, prepare and distribute to each party involved, notification of the status of each Alternate. Indicate whether Alternates have been accepted, rejected or deferred for consideration at a later date. Include a complete description of negotiated modifications to Alternates.

4.6 SCHEDULE OF ALTERNATES

Add Alternate #01: Microbiology Department, Rooms #110, 111, 112, 113, 114, and 115. Demolition and construction including associated mechanical unit located on the second floor, rooftop mounted exhaust, fire protection, plumbing systems, power, lighting, telecommunications, access control systems, security camera, fire alarm systems, and fit-up.

Add Alternate #02: Organic Chemistry Department, Rooms #101, 102, 103, and 109. Demolition and construction including associated mechanical unit located on the second floor, rooftop mounted exhaust, fire protection, plumbing systems, power, lighting, telecommunications, access control systems, security camera, fire alarm systems, and fit-up.

Base Bid: General Chemistry Department and Fire Riser, Rooms #109, 201, 202, 203, 204, 205, 206, 207, 208, 209, 220, 221, 222, 223, 224. Demolition and construction including associated mechanical unit located on the second floor, rooftop mounted exhaust, fire protection, plumbing systems, power, lighting, telecommunications, access control systems, security camera, fire alarm systems, fit-up, replacement of neutralization tank, and all associated utility connections.

END OF SECTION 012300

012400 VALUE ANALYSIS

012413 VALUE ENGINEERING

A. Following execution of the contract, the Contractor is encouraged to develop, prepare, and submit value engineering change order proposals (VECOP's). The Contractor shall share equally in any contract savings realized from accepted VECOP's.

B. The Contractor shall include the following information in each VECOP:

1. A description of the difference between the existing contract requirement and that proposed VECOP which includes 1) the requirements of Section 01 25

- 00.02, 2) the comparative advantages and disadvantages of each, and 3) a justification when an item's function or characteristics are being altered.
 2. A separate, detailed cost estimate for (a) the affected portions of the original contract requirement and (b) the VECOP. The cost reduction associated with the VECOP shall take into account the Contractor's overhead and profit.
 3. A statement of the time by which a contract modification accepting the VECOP must be issued in order to maximize cost reduction, and the effect, if any, on the Contract Time.
- C. Submission, review, and acceptance or non-acceptance of VECOP's shall be in accordance with standard change order proposal requirements. Change orders shall be issued for accepted VECOP's, reducing the Contract Sum by one-half the amount(s) indicated on the VECOP(s)

END OF SECTION

SECTION
012500 SUBSTITUTION PROCEDURES

012500.01 AFTER AWARD

Within 10 days after the award of contract, formal requests will be considered for substitutions of products specified as a minimum standard. After the end of that period, substitution requests will be considered only if the specified product or system has gone out of production, or has been deemed illegal or dangerous subsequent to bidding.

012500.02 SUBMITTING SUBSTITUTION

Submit separate requests for each substitution per 01 33 00. Include, at a minimum, in each request:

- A. Complete data substantiating compliance of proposed substitution with contract documents, include:
 1. Product identification, manufacturer's name and address.
 2. Product specifications and data per 01 33 00.
 3. Samples per 01 33 00 if applicable.
- B. Itemized comparison of proposed substitution with specified products, listing all variations, including size and weight.
- C. Data relating to changes in the construction schedule.
- D. Any effect on in-place construction or other materials and systems to be installed.
- E. Cost data comparing proposed substitution with specified products.
- F. Designation of availability of maintenance services and sources of replacement materials.
- G. Advantages to the owner of accepting the substitutions.

012500.03 SUBSTITUTIONS NOT CONSIDERED

Substitutions will **not** be considered when:

- A. They are indicated or implied on submittals without formal request.
- B. Acceptance may require revision of contract documents, unless contractor agrees to compensate owner for Architect's additional service.

012500.04 SUBSTITUTE PRODUCT

Substitute products shall not be ordered or installed without written acceptance of Architect.

01 25 00.05 SUBSTITUTION DATA

Based on the submitted data, the Architect will determine if the proposed substitution meets the requirements of the contract documents.

END OF SECTION

SECTION

012600 CONTRACT MODIFICATION PROCEDURES

PART 1 – GENERAL

0126 33 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."

012646 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

01 26 53 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of the proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of materials, supplies, and equipment (including cost of transportation, whether incorporated or consumed) required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Include applicable costs of premiums for all bonds and insurance, permit fees, taxes, delivery charges, equipment rental (exclusive of hand tools), and amounts of trade discounts required or eliminated.
 - c. Include costs of labor and supervision directly attributable to the change, including social security, old age and unemployment

- insurance, fringe benefits required by agreement or custom, and workers' compensation insurance required or eliminated.
- d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- e. Comply with requirements in Division 1 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.
- f. For deductive change order proposals, Contractor may add appropriate preparation costs.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Architect, properly itemized and supported by sufficient substantiating data to permit evaluation, plus a fee; such costs shall be itemized by crafts as defined within the schedule of values and limited to the following items directly attributable to the change in the Work:

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of materials, supplies, and equipment (including cost of transportation, whether incorporated or consumed) required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Include applicable costs of premiums for all bonds and insurance, permit fees, taxes, delivery charges, equipment rental (exclusive of hand tools), and amounts of trade discounts required or eliminated.
4. Include costs of labor and supervision directly attributable to the change, including social security, old age and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance required or eliminated.
5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Division 1 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.
7. For deductive change order proposals, Contractor may add appropriate preparation costs.

01 26 57 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701. Change Orders may combine more than one Proposal Request.

END OF SECTION

01 29 00.01 PAYMENT APPLICATION

Applications for payment must be submitted, in triplicate, to the attention of the Architect for certification and processing. Applications for payment will normally be processed and a check ready within 14 days after receipt of the certified pay application by the Owner. Applications for payment which are not properly submitted will be delayed. Applications for payment mailed to Pima College Accounts Payable are **NOT** properly submitted.

01 29 00.02 PROGRESS PAYMENT PROCEDURES

Contractor shall provide the items listed below with each application for payment. Applications for payment which do not include these items will not be certified.

- A. A copy of the Schedule of Values completed for the period of time covered by the application, including the percent of each task complete as shown on the updated project schedule. Use AIA document G703 certificate for payment continuation sheet. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of the Applications for Payment and progress reports. Correlate line items in the Schedule of Values with the Construction Schedule and sub-contractor list.
- B. Updated project schedule per section 01 32 16 showing the actual progress for each task during the pay application period.
- C. Invoices for materials stored on-site. Payment will not be made for materials stored off-site.
- D. Lien Waivers: after the first pay application, the contractor shall submit with each pay application a partial lien release for the work and partial lien releases from each subcontractor and/or for each separate line item on the schedule of values, for the work equal to the amount approved on the last application for payment, less retainage.
- E. As-built drawings for completed elements of the Work (indicated as 100% completed on G703).
- F. Operation and maintenance manuals for fully-installed and operational equipment (indicated as 100% completed on G703).

012900.03 PROGRESS PAYMENT

Payments on account of this Contract will be made monthly as Work progresses. The Contractor shall submit to the Owner through the Architect, in the manner and form prescribed by the Owner, an application for each payment, and, if required, receipts or other vouchers showing its payments for materials suitably stored at the construction site and labor, including applications from and payments to Subcontractors.

012900.04 INVOICE DETAIL

Invoices shall include the following: Contractor's invoice number; invoice date; official project title; current purchase order number and reference to any change orders for which payment is being requested; number of invoice pages; and dates covered by the invoice. Payment of invoices that do not contain the correct current purchase order may be delayed.

012900.05 RETENTION

Retention: All invoices shall provide a line item indicating retention of 10% of the dollar amount due at the time. Retention will be held until the end of the project. Final Payment of retention will not occur until all punchlist items are completed in a manner acceptable to the Owner.

012900.06 PROMPT PAY

The Contractor shall promptly pay each Subcontractor, upon receipt of payment from the Owner, out of the amount paid to the Contractor on account of such Subcontractor's portion of the Work, the amount to which said Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of such Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

END OF SECTION

SECTION
013119 PROJECT MEETINGS:

013119.01 PRECONSTRUCTION MEETINGS

A pre-construction conference will be called by the Owner's Representative for the purpose of discussing execution of the work. The Contractor and any subcontractors whose presence is necessary or requested must attend.

013119.02 COORDINATION MEETINGS

Job site Coordination Meetings may be called by Owner as deemed necessary to coordinate, expedite, or schedule the work of this contract.

013119.03 PROGRESS MEETINGS

When construction/installation begins, weekly Progress Meetings will be held at the job site with the Owner's representative, Architect's representative, and Contractor's Project Manager and Site Superintendent. The Contractor will report on the progress of the construction, review "as-built" conditions, provide an update on the schedules, and notify the Architect and/or Owner of any action required on their part prior to the next meeting.

END OF SECTION

SECTION
013200 CONSTRUCTION PROGRESS DOCUMENTATION:

013216 CONSTRUCTION SCHEDULE

- A. Work schedule shall be coordinated with the Owner's Representative.
- B. Prepare the construction schedule as follows:
 - 1. The schedule shall be a Gantt (bar chart) with a horizontal time scale and activities listed vertically or a time scaled network diagram (CPM). Note on the schedule any assumptions made, including but not limited to, request for information (RFI) turnaround times.
 - 2. At a minimum, no task on the schedule shall have duration greater than 15 (calendar) days. All activities shall include tasks for shop drawing review or other submittals, approvals, procurement, fabrication, delivery, installation, start-up and testing as required. The schedule shall clearly indicate the start and completion date of each activity.
- C. The schedule shall anticipate the following number of days as normal adverse weather (rain) days: Six (6). No extension of the Contract Time will be granted unless the actual adverse weather days exceed the cumulated normal adverse weather days for the duration of the Contract Time and the actual adverse

weather days had an effect on the scheduled construction. The number of adverse weather days was determined by using the following number of average days with greater than one quarter (1/4) inch of rain in Tucson:

Month	Weather Days	Month	Weather Days	Month	Weather Days
January	1	May	0	September	1
February	1	June	1	October	0
March	1	July	2	November	1
April	0	August	2	December	2

- D. If the architect determines that the start or completion of any activity on the schedule deviates from the schedule by more than seven days, the contractor shall revise and reissue the schedule within seven days of the determination that an activity has deviated by more than seven days.
- E. A CPM schedule will be required to request an adjustment in the Contract Time.

END OF SECTION

SECTION
013300 SUBMITTAL PROCEDURES:

013300.01 START-UP SUBMITTALS

Start-up Submittals: Within 10 days after the award of the contract, submit:

- A. Three (3) copies of schedule of values per Division 1, Section 01 29 00.02.
- B. Three (3) copies of the shop drawing review schedule per Division 1, Section 01 33 23.
- C. Three (3) copies of the construction schedule for the work per Division 1, Section 01 32 16.
- D. A letter stating which individual within the Contractor's organization is authorized to sign change orders on behalf of the Contractor.
- E. No construction work shall be started and no progress payments made until the above are submitted and accepted.

013300.02 OTHER COMMUNICATIONS

- A. Project Communications: Routine written communications between the contractor and the architect shall be in letter, field memo or fax format. Such communication shall not substitute for any other written requirement or submittal.
- B. Request for Information (RFI): A request from the Contractor seeking an interpretation or a clarification of some requirement of the contract documents. The contractor shall clearly and concisely set forth the issue for which they seek clarification or interpretation and why a response is needed. The contractor shall, in the written request, set forth their interpretation or understanding of the contract's requirements along with the reasons why they have reached such an understanding. Responses to the RFI will not change any requirements of the contract documents unless so noted in the Request for Information Response.
- C. Drawing/Plan Clarification: An answer from the architect, in response to an inquiry from the contractor, intended to make some requirement(s) of the

drawings or plans clearly understood. Drawing clarifications/plan clarifications may be sketches, drawings or in narrative form and will not change any requirements of the drawings or plans.

013300.03 SAFETY DATA SHEETS (SDS)

- A. Provide the Owner with MSDS for all material which may affect the Owner's students or staff 10 days prior to delivery of material to the job site.
- B. Contractor shall maintain binder at the job site with MSDS for all materials used in the work.

013323 SHOP DRAWINGS AND MANUFACTURER'S DATA

- A. Review Times: the shop drawing review schedule shall include 10 working days for review of submittals by the architect. Revise shop drawing review schedule and resubmit when progress deviates from previous schedule by 7 days. The shop drawing review tasks must be included with the construction schedule. (See section 01 32 16)
- B. Submit four (4) copies of shop drawings (owner will retain one set). Provide drawing scale large enough to clearly show all elements of the work. Show how adjacent work relates. Reference to sheet, detail and/or schedule.
- C. Submit four (4) copies of manufacturer's standard product data. Include reference standards and warranty information. Provide references to sheet, detail, schedule, and/or specification section. Show dimensions and clearances specific to the work.
- D. Submittals without indication of Contractor's review and approval will be returned without Architect's review.

END OF SECTION

SECTION

014100 REGULATORY REQUIREMENTS:

014100.01 STANDARDS, CODES, AND LAWS:

- A. Project shall be completed in accordance with federal, state, and local codes, laws, regulations, and rules that govern such operations, including fire codes.
- B. Material and products are specified for their appropriateness in the completed work. The contractor is responsible for providing training and education to the Contractor's employees and obtaining and distributing information regarding the potential dangers and appropriate safety measures for material and products during the work as required by the Occupational Safety and Health Administration, Hazard Communication Standard and the State of Arizona.

014100.02 PERMITS AND LICENSES:

The Owner shall make all document submittals and secure all required permits, paying all fees in that regard. The Contractor shall arrange for inspections as required, and secure necessary approvals. [No City or County permits except dust control are required for College work.]

END OF SECTION

SECTION
015000 TEMPORARY FACILITIES AND CONTROLS:

SECTION
015100 TEMPORARY UTILITIES:

- A. Prior to start of ANY trenching or excavation, Contractor shall employ a specialist to locate all utilities; including irrigation lines, in areas not under the jurisdiction of Bluestake, and shall include expense of such work in Bid. Contractor shall call for Bluestake, review As-Built drawings and other information supplied by the Owner, as well as information provided by utility location specialist, prior to submitting the initial Construction Schedule. Any down time for utilities that may be required due to the location of utility lines found, shall be shown on the initial Construction Schedule. See Section 01 32 16.
- B. Owner will furnish temporary water and electricity from existing points of connection. Temporary extensions shall be the responsibility of the Contractor and shall be made and maintained in a safe and secure condition. Any meters, backflow preventers, or temporary use permits shall be the responsibility of the Contractor.

END OF SECTION

SECTION
015200 CONSTRUCTION FACILITIES:

015213 FIELD OFFICES AND SHEDS:

- A. Field Office will be required.
- B. Contractor's superintendent shall have, as a minimum, a cellular telephone and shall provide the telephone number to the owner and architect.

015219 SANITARY FACILITIES:

- A. The contractor **shall not** use College rest rooms for any construction purpose. Arrangements may be made to use existing toilet facilities for non-construction purposes. Provide portable toilets for contractor personnel.

END OF SECTION

SECTION
015500 VEHICULAR ACCESS AND PARKING

015500.01 TEMPORARY ACCESS ROADS AND PARKING:

- A. General Access to the site shall be coordinated with Facilities and Campus.
- B. Parking arrangement for Contractor's crew to be made during pre-construction conference. Contractor will be responsible for restricting employees', sub-contractors' and suppliers' vehicles to the designated area.

END OF SECTION

SECTION
015600

TEMPORARY BARRIERS AND ENCLOSURES

015616

TEMPORARY DUST BARRIERS:

Controlling construction-related dust and preventing the spread of flying particles is the Contractor's responsibility. HVAC return air paths must be sealed to prevent dust and odors from spreading to occupied parts of the building.

015623

TEMPORARY BARRICADES AND WARNING SIGNS:

- A. Contractor shall furnish, erect, and maintain barricades, barriers, and warning signs, etc., required for protection of persons and property in compliance with applicable statutes, **at a minimum a chain link fence enclosing construction area (from Campus) will be required.**

015636

TEMPORARY SECURITY ENCLOSURES:

- A. Contractor is responsible for: providing appropriate safety and warning signs; securing materials stored on site to prevent theft; and securing the work in-place to prevent vandalism.
- B. The contractor will be issued a set of keys for access to existing Owner facilities if required. The contractor will be responsible for loss or theft of keys issued and will be liable for the cost of re-keying all or a portion of the Owner's existing facilities.

015670

COVID-19 SAFETY

- A. Pima College requires that all Contractors working for it in any capacity on any of its campuses or owned or managed facilities adhere to prescribed Covid-19 safety protocols and shall provide for Owner review a plan to implement protocols for the duration of the project. Following are general guidelines for implementation at these areas.
- B. All Contractors shall comply with OSHA requirements, in particular the general requirements of OSHA Covid-19 Guidance for the Construction Workforce (included herein). Also comply with the Centers for Disease Control (CDC) Construction Covid-19 Checklist for Employers and Employees.
- C. The Contractor is responsible for developing circulation plan for workers; taking of temperatures and daily general worker conditions and maintaining logs of such; proper and consistent use of personal protection equipment; and other measures as prescribed by the cited standards, and local jurisdiction. All monitoring and implementation of the protocols is the responsibility of the General Contractor.
- D. For this particular project Pima College requires that the immediate building site be provided a portable construction fence, chain link, minimum 6' high, in place around the entire site for the duration of the project. This is intended not only to

protect the project site, but to positively segregate the construction workforce from the school staff, visitors and students.

END OF SECTION

SECTION
016000 PRODUCT REQUIREMENTS

016000.01 PRODUCT OPTIONS

ANY BRAND NAMES OR NAMES OF MANUFACTURERS LISTED IN THE CONTRACT DOCUMENTS ARE ONLY PROVIDED AS GUIDELINES FOR THE PURPOSE OF ESTABLISHING MINIMUM ACCEPTABLE STANDARDS, UNLESS SPECIFICALLY IDENTIFIED AS SOLE SOURCE ITEMS.

END OF SECTION

SECTION
016500 PRODUCT DELIVERY REQUIREMENTS

016500.01 DELIVERY & STORAGE

- A. Deliveries may be made directly to job site, however, it shall be the sole responsibility of the Contractor to receive, handle, and store such items in a safe and secure manner.
- B. Materials required for this project shall be stored on-site at locations and in a manner mutually acceptable to Owner and Contractor. Store materials per the manufacturer's written instructions.

016500.02 MAINTENANCE OF IN-PLACE MATERIALS AND CONSTRUCTION

- A. Provide maintenance per manufacturer's written instructions and recommendations, and industry recommendations until substantial completion.
- B. Maintenance required elsewhere in the contract documents shall continue after substantial completion if specified.

016500.03 INSTALLATION INSTRUCTIONS

- A. Materials and equipment incorporated into the work shall be installed or applied per the manufacturer's written instructions, specifications (including guide specifications), and recommendations; unless specifically modified by written instruction from the manufacturer. Submit any modifications to Architect as product data.

016500.04 ITEMS OF THE SAME KIND ARE TO BE BY THE SAME MANUFACTURER.

END OF SECTION

SECTION
017329 CUTTING AND PATCHING

017329.10 GENERAL

017329.11 RELATED DOCUMENTS

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

017329.12 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. Related Sections include the following:
1. Division 1 Section "Selective Demolition" for demolition of selected portions of the building.
 2. Divisions 2 through 48 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

017329.13 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

017329.14 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or those results in increased maintenance or decreased operational life or safety. Operating elements include the following:
1. Primary operational systems and equipment.
 2. Fire-suppression systems.
 3. Mechanical systems piping and ducts.
 4. Control systems.
 5. Communication systems.
 6. Electrical wiring systems.
- C. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

017329.20 PRODUCTS

017329.21 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

SECTION
017329.30 EXECUTION

017329.31 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

017329.32 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

017329.33 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend from one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance.
 - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or re-hang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather-tight condition

- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 017329

SECTION
017700

CLOSEOUT PROCEDURES:

017700.01 INITIATE SUBSTANTIAL COMPLETION

Initiate Substantial Completion procedures a minimum of [15] days prior to the date for substantial completion.

01700.02 PRIOR TO SUBSTANTIAL COMPLETION

Prior to substantial completion, complete the following

- A. Contractor prepared punchlist of all incomplete items and corrections to be made.
- B. Punchlist: When the Contractor considers that the Work is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected. By submitting a request for substantial completion inspection the Contractor thereby certifies that the Work, or the designated portion, is functionally ready for Occupancy by the Owner and that the remaining incomplete or defective work required by the Contract Documents shall be completed within 30 days. The Contractor shall proceed promptly to complete and correct items on the list. Failure to include an item on the list does not alter the responsibility of the Contractor to complete all work in accordance with the Contract Documents.
- C. Schedule punchlist inspection with the Owner's Representative in order to exhibit the completeness of the work. Owner's Representative will not participate in an inspection unless a full punchlist is submitted 5 days prior to inspection.
- D. Remove all temporary facilities and controls.
- E. Complete final cleanup requirements, including touchup painting.

017700.03 PUNCHLIST:

- A. If the Architect's inspection discloses an item, whether or not included on the Contractor's Punchlist, which is not in accordance with the requirements of the Contract Documents, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct the item upon notification by the Architect to determine Substantial Completion. When the Work or designated portion is substantially complete, the Architect will prepare a Certificate of Substantial Completion which shall establish responsibilities of the Owner and Contractor for maintenance, damage to the Work, insurance, and the Final Punchlist and shall fix the time within which the Contractor shall finish all items on the Final Punchlist accompanying the Certificate. Satisfactory completion of all items on the Final Punchlist shall be final completion of the work. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion unless otherwise provided in the Certificate of Substantial Completion. The Project shall not be deemed

substantially complete until the Certificate is issued.

- B. Neither Final Payment nor any remaining retainage or substituted securities shall become due until the Contractor submits to the Owner:
 - 1. an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work have been paid or otherwise satisfied,
 - 2. consent of surety to final payment or release of substituted securities and other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract.
- C. Acceptance of final payment by the Contractor, Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Invoice.
- D. The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the contract documents, whether observed before or after Substantial Completion and whether or not fabricated, installed or completed. The contractor shall bear costs of correcting such rejected work, including additional testing and inspections and compensation for the Architect's services and expenses made necessary thereby
- E. If the Contractor fails to correct nonconforming Work within a reasonable Time, the Owner may correct it. If the Contractor does not proceed with correction of such nonconforming Work within a reasonable time fixed by written notice from the Architect, the Owner may remove it and store the salvageable materials at the Contractor's expense.

017700.04

RECORD DRAWINGS AS-BUILTS:

- A. Maintain a clean, undamaged set of blue or black line white-prints of Contract Documents and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Tape or paste addenda, architect's supplemental instructions, proposal requests and other information onto the appropriate sheet to provide a complete record of the work.
- B. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
- C. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings
- D. Note related Change Order numbers where applicable.
- E. Organize record Shop Drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set. Upon completion of the work, submit complete sets to the Architect.
- F. Upon completion of the work, the Contractor shall deliver to the Architect these record drawings "as-builts". These record drawing "as-builts" shall be transferred to electronic media by the owner.

017700.05 MAINTENANCE MANUALS:

Provide two (2) hard copies and one electronic copy (pdf) of the closeout submittals in three ring notebooks with section tabs, organized in CSI format:

- A. Updated subcontractor list with names and phone numbers.
- B. From each subcontractor and material and equipment supplier, provide the following:
 - 1. Guarantees and Two (2) year Warranties.
 - 2. Operation and Maintenance data, including:
 - a. Emergency instructions
 - b. Spare Parts list
 - c. Wiring diagrams
 - d. Recommended "turn around" cycles
 - e. Inspection procedures
 - f. Shop Drawings and Product Data
 - g. Special inspection documentation
 - 3. Testing Reports.

017700.06 PRIOR TO FINAL PAYMENT

Prior to Final Payment complete the following:

- A. Schedule a time with the Architect and Owner to inspect the work following the completion by the Contractor of the final punchlist.
- B. Provide a letter documenting that the project has been completed in accordance with Contract Documents and Warranting materials and work.
- B. Provide Operations and Maintenance instructions
 - 1. Maintenance Manuals
 - 2. Record Documents
 - 3. Cleaning
 - 4. Warranties and Bonds.
- C. Certificate of occupancy. (If applicable)
- D. Submit a final Liquidated Damages or Early Completion Bonus settlement statement.

017700.07 CLEANING:

- A. Final Cleaning:
 - 1. Thoroughly clean the interior and exterior of the project areas, removing misplaced mastic, paint, and other finishes. Remove dust, dirt, and stains from new and existing materials.
 - 2. Sweep all exterior paving areas, remove debris and stains. Remove debris from landscaping areas. Rake and/or remove debris from all other areas affected by the work.

END OF SECTION

SECTION
017836
017836.01

WARRANTIES:
WARRANTY PERIOD

Unless noted otherwise as extended, standard warranty period shall be two (2) years from the date of Substantial Completion.

017836.02 EXCLUSIONS

The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the work will be free from defects not inherent in the quality required or permitted, and that the Work will conform with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.

017836.03 CONTRACTOR GUARANTEE

Neither the final payment nor any provision in the Contract Documents shall constitute an acceptance of the Work not done in accordance with the Contract Documents or relieve the Contractor or its sureties of liability with respect to any warranties or responsibility for faulty materials and workmanship. The Contractor guarantees that the Work will conform to the Contract Documents.

017836.04 FAILURE TO REMEDY DEFECTS

If the Contractor fails to remedy any defects or damage, the Owner may correct the Work or repair the damages, and the cost and expense incurred in such event shall be paid by or be recoverable from the Contractor or Surety, or offset against any amounts owing the Contractor.

017836.05 TIME OF WARRANTY SUBMISSION

Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

017836.06 WARRANTY SUBMISSION

Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

- A. Bind warranties and bonds in 3-ring, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8 ½ x 11.
- B. Provide dividers with plastic-covered tabs for each separate warranty. Mark tab to identify product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address and telephone number of the installer.
- C. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

017836.07 ADDITIONAL COPIES

Provide additional copies of each warranty to include in operation and maintenance manuals.

END OF SECTION

SECTION

018930 SELECTIVE DEMOLITION

018930.10 GENERAL

018930.11 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Salvage of existing items to be reused or recycled.

018930.12 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

018930.13 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI A10.6 and NFPA 241.

018930.14 PROJECT CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and

Owner. Owner will remove hazardous materials under a separate contract.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

018930.20 PRODUCTS (Not Used)

018930.30 EXECUTION

018930.31 EXAMINATION

A. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

B. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

018930.32 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off indicated utilities with utility companies.

2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

018930.33 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

018930.34 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods

required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 5. Dispose of demolished items and materials promptly.
- B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

018930.35 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
- B. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

018930.36 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 018930

END OF DIVISION 1

SECTION 02 119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

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

1.2 SUMMARY

A. This Section requires the selective removal and subsequent offsite disposal of the following:

1. Existing interior and exterior construction as noted.

1.3 JOB CONDITIONS

A. Condition of Structures: Owner assumes no responsibility for actual condition of items or structures to be demolished. Conditions existing at time of inspection for bidding purposes will be maintained by Owner insofar as practicable.

B. Damages: Promptly repair damages caused by demolition work to adjacent work to remain.

C. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with adjoining buildings and student/teacher pedestrian circulation. Provide barriers, tape, fencing and other means to ensure safety of occupants of adjacent structures.

D. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

E. Environmental Controls: Use temporary enclosures, ongoing cleaning procedures, extra ventilation or exhaust, and other methods as needed to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.

1. Protect openings made in exterior walls or roof against weather. Close openings with new work as quickly as possible, and while open protect with plywood, plastic sheeting or another material against weather intrusion. If openings present a security risk, cover with temporary fencing.

F. Hazardous Materials: If the Contractor suspects the presence of asbestos-containing or other hazardous materials at an area on the job site, stop work in this area immediately, leave the materials undisturbed and immediately contact the Owner and the Architect's Representative for direction.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Provide shoring, bracing, or support to prevent movement, settlement, or collapse of areas to be demolished and adjacent facilities to remain.

1. Cease operations and notify Owner's Representative immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.
 2. Erect and maintain weatherproof closures for exterior openings resulting from demolition work.
 3. Locate, identify, stub off, and disconnect utility services that are not indicated to remain.
- 3.2 SALVAGE: Owner will remove any materials they wish to salvage from the building prior to the beginning of the work. Everything remaining will become the property of the Contractor unless otherwise noted on the drawings (confirm with Owner at time of anticipated demolition).
- 3.3 DEMOLITION
- A. General: Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
 1. Drill holes or perform cutting in concrete or masonry using suitable tools to minimize damage to adjacent materials to remain, and not to create larger openings than required for removal of materials.
 - B. If unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner's Representative in written, accurate detail. Pending receipt of directive from Owner's Representative, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.
 - C. Provide temporary shoring as needed to support openings or areas where removal of elements could compromise structural integrity. Leave in place until permanent support has been installed.
- 3.3 DISPOSAL OF DEMOLISHED MATERIALS: Remove from the site and dispose of in a legal manner. Recycling, reuse, or resale of materials is encouraged.
- 3.4 PATCHING: Patch areas where new work has impinged on existing structures or materials to remain. Use materials of composition, color and texture that are indistinguishable from the adjacent remaining work.

END OF SECTION 024119

SECTION STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 0 4000 Cold-Formed Steel Framing.

1.2 SUMMARY

- A. This Section includes fabrication and erection of structural steel work, as shown on drawings including schedules, notes, and details showing size and location of members, typical connections, and types of steel required.
 - 1. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice" and as otherwise shown on drawings.
 - 2. Miscellaneous Metal Fabrications are specified in Section 0 000.
 - 3. Touching-up of steel primers.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
 - 1. Structural steel primer paint.
 - 2. Shrinkage-resistant grout.
- C. Shop drawings, including complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
 - 1. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld.
 - 2. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.
- D. Test reports conducted on shop- and field-bolted and welded connections. Include data on type(s) of tests conducted and test results.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except as otherwise indicated:
1. American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence:
 - 1) "This approval constitutes the owner's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as a part of his preparation of these shop drawings."
 2. AISC "Specifications for Structural Steel Buildings," including "Commentary."
 3. "Specifications for Structural Joints using ASTM A 32 or A 490 Bolts" approved by the Research Council on Structural Connections.
 4. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
 - . ASTM A "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use."
 - . Attachment and inspection of headed studs shall conform to all requirements of the latest edition of the Recommended Practices for Stud Welding and The Structural Welding Code published by AWS.
- B. Qualifications for Welding Work: Qualify welding procedures and welding operators in accordance with AWS "Qualification" requirements.
1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
 2. If recertification of welders is required, retesting will be Contractor's responsibility.
 3. High-strength bolting shall be inspected by an independent testing laboratory to ensure bolt tension.

1. DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.
- B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not to delay work.
- C. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. If bolts and nuts become dry or rusty, clean and relubricate before use.

1. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metal Surfaces, General: For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and applying surface finishes.
- B. W-Shapes: ASTM A992 Grade 50.
- C. Channels and Angle Shapes, Plates, and Bars: ASTM A36, Fy 36 KSI.
- D. Cold-Formed Steel Tubing (rectangular HSS): ASTM A656, Grade B, Fy 42 KSI.
- E. Cold-Form Steel Piping (round HSS): ASTM A513, Grade B, Fy 42 KSI..
- F. Bolts: ASTM A325 N, Type 1.
- G. Headed Studs: Nelson Type H4L or S3L or approved equal and shall conform to ASTM A193, grades 101 or 1020 with a minimum tensile strength of 100 KSI.
- H. Deformed Bar Anchor Studs: Nelson D2L studs or approved equal with a minimum tensile strength of 60 KSI. Anchor Bolts: ASTM A307 or A308. Anchor rods shall be ASTM F1554, Grade 36.
- I. Threaded Rods: ASTM A307.
- J. Epoxy Bolts or Dowels: Threaded rod or reinforcing steel installed with set adhesive by Simpson per ICBO Report ER-209.
- K. Expansion Anchors for Concrete: Kwik bolt TZ by Hilti installed per ICBO Report ESR-191. Expansion bolts for masonry shall be Kwik Bolt III by Hilti, installed per ICBO Report ESR-133.

- L. Electrodes for Welding: Comply with AWS Code. E 0 Series low hydrogen rods unless noted otherwise E90 series for Grade 0 reinforcing bars.
- M. Structural Steel Primer Paint: SSPC - Primer: SSPC-Paint 23, latex primer.
- N. Nonmetallic Shrinkage-Resistant Grout: Shall be 000 psi Five Star, Sika 212 or equal.

2.2 FABRICATION

- A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.
 - 1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.
 - 2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
- 1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
- 2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
- 3. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
- 4. Fabricate to the tolerances specified in AISC 303.
- B. Connections: Weld or bolt shop connections, as indicated.
- C. Bolt field connections, except where welded connections or other connections are indicated.
- D. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.
 - 1. Grind smooth and flush with adjacent surfaces all welds on exposed structural steel.
- E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

- G. Provide threaded nuts welded to framing and other specialty items as indicated to receive other work.
- H. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 SHOP PAINTING

- A. General: Shop-paint structural steel, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel that is partially exposed on exposed portions and initial 2 inches of embedded areas only.
 - 1. Do not paint surfaces to be welded or high-strength bolted with friction-type connections.
 - 2. Apply 2 coats of paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- B. Surface Preparation: After inspection and before shipping, clean steelwork to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) as follows:
 - 1. Interior: SSPC-SP /NACE No. 4, "Brush-Off Blast Cleaning."
- C. Painting: Immediately after surface preparation, apply structural steel primer in at least two coats in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 1. mils per coat. Use painting methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.4 SOURCE QUALITY CONTROL

- A. General: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
 - 1. Promptly remove and replace materials or fabricated components that do not comply.
- B. Design of Members and Connections: Details shown are typical similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.
 - 1. Promptly notify Architect whenever design of members and connections for any portion of structure are not clearly indicated.

PART 3 - EXECUTION

3.1 ERECTION

- A. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.
- B. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.
- C. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
 - 1. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.
 - 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 - 3. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. See Structural Notes for sequence of grouting. Finish exposed surfaces, protect installed materials, and allow to cure.
 - 4. For proprietary grout materials, comply with manufacturer's instructions.
- D. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- E. Level and plumb individual members of structure within specified AISC tolerances.
- F. Splice members only where indicated and accepted on shop drawings.
- G. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.
 - 1. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 2. Do not enlarge unfair holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
- H. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to Architect. Finish gas-cut sections equal to a sheared appearance when permitted.

- I. Touchup Painting: Clean and touchup field welds, bolted connections, and abraded areas of shop paint on structural steel.

3.2 QUALITY CONTROL

- A. Owner will engage an independent testing and inspection agency to perform inspections as detailed on the drawings.
- B. Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically state any deviations.
- C. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.
- D. Testing agency may inspect structural steel at plant before shipment.
- E. Correct deficiencies in structural steel work that inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as necessary to reconfirm any noncompliance of original work and to show compliance of corrected work.
- F. Shop-Bolted Connections: Inspect or test in accordance with AISC specifications.
- G. Shop Welding: Inspect and test during fabrication of structural steel assemblies, as follows:
 1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
 2. Perform visual inspection of all welds.
- H. Field Welding: Inspect and test during erection of structural steel as follows:
 1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
 2. Perform visual inspection of all welds.
 3. Multi-pass fillet welds and full penetration welds shall be continuously inspected.

END OF SECTION 0 1200

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Exterior non-load-bearing wall framing.

- B. Related Requirements:

- 1. Section 0 000 - Metal Fabrications.
 - 2. Section 092900 Gypsum Drywall Systems for light-gage framing members.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cold-formed steel framing product and accessory.

- B. Shop Drawings:

- 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing fabrication and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Data: For each type of steel framing product and accessory.

- B. Welding certificates.

- C. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.

- 1. Expansion anchors.
 - 2. Power-actuated anchors.
 - 3. Mechanical fasteners.
 - 4. Vertical deflection clips.
 - . Horizontal drift deflection clips
 - . Miscellaneous structural clips and accessories.

- D. Research Reports: For cold-formed steel framing, from ICC-ES.

1. QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1. DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 COLD-FORMED STEEL FRAMING, GENERAL

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - 1. Grade: ST33H (ST230H) for 1 ga. and less
 - 2. Grade: ST 0H (ST340h) for 1 ga, and more
 - 3. Coating: G 0 (Z1 0).
- B. Steel Sheet for Clips: ASTM A 3/A 3M, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: 33 (23) for 1 ga. and less
 - 2. Grade: 0 (340), Class 1 for 1 ga. and more
 - 3. Coating: G 0 (Z1 0).

2.2 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as shown on drawings.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as shown on drawings.
- C. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as shown on the drawings.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.3 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - . End clips.
 - . Stud kickers and knee braces.

2.4 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 3 /A 3 M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC 0, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- C. Mechanical Fasteners: ASTM C 1 13, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

- D. Welding Electrodes: Comply with AWS standards.

2. MISCELLANEOUS MATERIALS

- A. Primer: Manufacturer's recommended.
- B. Cement Grout: Portland cement, ASTM C 150, Type I and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 110 /C 110 M, with fluid consistency and 30-minute working time.
- D. Shims: Load bearing, high-density multimonomer plastic, and nonleaching or of cold-formed steel of same grade and coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, minimum thickness, width to match width of bottom and top track.

2. FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:90) and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/16 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- B. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 1. Cut framing members by sawing or shearing do not torch cut.
 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 0 2100 - Thermal Insulation, in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/4 inch in 10 feet (1:90) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/4 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Sill Sealer: Install continuously at all perimeters of framing where it abuts cement slab and deck above, and at junctures to existing metal panel walls.
- B. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- C. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: 16 inches.
- D. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- E. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
- F. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not less than 12" on center. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3. FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3. REPAIRS AND PROTECTION

A. Primer Repair: Re-touch damaged factory primed areas using same primer as initially applied to members.

B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 0 4000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel framing and supports for mechanical and electrical equipment.
 - 2. Steel lintels.
 - 3. Steel connective hardware.
 - 4. Alternating tread ladder.
- B. Related Sections include the following:
 - 1. Section 0 1200 - Structural Steel.
 - 2. Section 0 4000 Cold-Formed Steel Framing.
 - 3. Section 0 1000 Rough Carpentry
 - 4. Section 0 200 Roof Hatch
 - . Section 099000 - Painting.

1.3 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change (Range): 120 deg F ambient 1 0 deg F, material surfaces.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 2. Provide templates for anchors and bolts specified for installation under other Sections.
 - 3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Alternating Tread Ladder: Fabrication and installation shop drawings. Field verify floor to-ceiling height for length of ladder.

C. Welding certificates.

1. QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
AWS D1.3, "Structural Welding Code--Sheet Steel."

1. PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1. COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 3 /A 3 M.
- B. Steel Tubing: ASTM A 00, cold-formed steel tubing.

- C. Steel Pipe: ASTM A 3/A 3M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
- D. Iron Castings: Gray iron, Class 3 -B, or better, for heavy duty use.
- E. Alternating Tread Ladder: OSHA 1910.2 compliant deg. steel ladder. Extra heavy duty bar grading treads 1-1/2 x 11 ga. welded tube railings 10 structural stringer with x 10 flat bar center member. 11 wide treads with overall stair width 2 -1/4 . Shipped knocked down for bolted assembly. Powder coat finish in a standard color as selected. Provide with hatch access top rail for 12 hatch curb.

Equal FSI Engineered Steel Products Steel Alternating Tread Stair, fsindustries.com, 00-421-0314.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 33, Class Fe/Zn , at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Anchor Bolts: ASTM F 1 4, Grade 3 .
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- C. Eyebolts: ASTM A 4 9.
- D. Machine Screws: ASME B1 . .3.
- E. Lag Bolts: ASME B1 .2.1.
- F. Wood Screws: Flat head, ASME B1 . .1.
- G. Plain Washers: Round, ASME B1 .22.1.
- H. Lock Washers: Helical, spring type, ASME B1 .21.1.
- I. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 4 , conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type galvanized ferrous castings, either ASTM A 4 /A 4 M malleableiron or ASTM A 2 /A 2 M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 1 3/A 1 3M.
- J. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 4 , conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 33, Class Fe/Zn .

2. Material for Anchors in Exterior Locations: Stainless-steel bolts complying with ASTM F 93 and nuts complying with ASTM F 94.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI 9.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 110 . Provide grout specifically recommended by manufacturer for interior and exterior applications.

2. FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2. MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Furnish inserts if units are installed in existing construction.

2. MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

2. FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.9 STEEL AND IRON FINISHES

- A. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP /NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- B. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Coat iron that will be in contact with fresh concrete as recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation with edges and surfaces level, plumb, true, and free of rack and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION 0 000

SECTION 0 000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Dimensional lumber, nailers, blocking, bucks, and hardware.
 - 2. Sheathing for walls and ceilings.
 - 3. Miscellaneous wall panels.
- B. Section 0 4000 Cold-Formed Framing.
- C. Section 092900 Gypsum Drywall Assemblies for light-gage framing.

1.3 DEFINITIONS: Rough carpentry includes carpentry work not specified as part of other Sections.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Material certificates for dimensional lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use as well as design values approved by the Board of Review of American Lumber Standards Committee.
- C. Wood treatment data as follows including chemical treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material:
 - 1. For each type of preservative treated wood product include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
 - 2. For fire-retardant-treated wood products include certification by treating plant that treated material complies with specified standard and other requirements.
 - 3. Material test reports from qualified independent testing laboratory indicating and interpreting test results relative to compliance of fire-retardant-treated wood products with requirements indicated.
 - 4. Warranty of chemical treatment manufacturer for each type of treatment.

1. DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

- A. Lumber Standards: Furnish lumber manufactured to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.
- B. Inspection Agencies: Inspection agencies and the abbreviations used to reference them with lumber grades and species include the following:
 1. WCLIB - West Coast Lumber Inspection Bureau.
 2. WWPA - Western Wood Products Association.
- C. Grade Stamps: Provide lumber with each piece factory-marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.
 1. Provide dressed lumber, S4S, unless otherwise indicated.
 2. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.
- E. Dimension Lumber: Provide Douglas-fir-larch lumber with grade and allowable stresses as indicated on the structural drawings.

2.2 DIMENSION LUMBER FRAMING

- A. Maximum Moisture Content: 19 percent for 2-inch nominal thickness or less, no limit for more than 2-inch nominal thickness.
- B. Grade: "Standard" grade light-framing-size lumber of Douglas Fir-Larch species or board-size lumber as required, provide stress ratings as noted on the structural drawings.

2.3 MISCELLANEOUS LUMBER

- A. General: Provide lumber for support or attachment of other construction including bucks, nailers, blocking, and similar members.
- B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
- C. Moisture content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.

- D. Grade: "Standard" grade light-framing-size lumber of any species or board-size lumber as required. "No. 3 Common" or "Standard" grade boards per WCLIB or WWPA rules or "No. 2 Boards" per SPIB rules.

2.4 CONSTRUCTION PANELS, GENERAL

- A. Construction Panel Standards: Comply with PS 1 "U.S. Product Standard for Construction and Industrial Plywood" for plywood construction panels and, for products not manufactured under PS 1 provisions, with APA PRP-10 .
- B. Trademark: Furnish construction panels that are each factory-marked with APA trademark evidencing compliance with grade requirements.

Provide panels UNMARKED where they will be exposed to view.

- C. Wall Sheathing: APA RATED SHEATHING (plywood or oriented strand board):

- 1. Thickness: 3/4
- 2. Span/Index Ratio: 32/1
- 3. Exposure Durability Classification: EXPOSURE 1

- D. Ceiling Sheathing: APA RATED SHEATHING (plywood or oriented strand board).

- 1. Exposure Durability Classification: EXPOSURE 1
- 2. Span/Index Ratio: 32/1 .
- 3. Thickness: / nominal (19/32).

2. CONCEALED PERFORMANCE-RATED CONSTRUCTION PANELS

- A. General: Where construction panels are indicated for the following concealed types of applications, provide APA Performance-Rated Panels complying with requirements designated under each application for grade designation, span rating, exposure durability classification, edge detail (where applicable), and thickness.
- B. Construction Panels for Backing:
 - 1. Plywood Backing Panels: For mounting electrical or communications equipment, provide fire-retardant-treated plywood panels with grade designation, APA C-D PLUGGED EXTERIOR, not less than 1 /32 inch, unless otherwise indicated. Paint to match adjacent walls in accordance with Section 099000, leaving a FIRE RETARDANT label visible on each wall.

2. FASTENERS AND ACCESSORIES

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Fasteners used in exterior applications shall be non-corrosive.
- B. Nails, Wire, Brads, and Staples: FS FF-N-10 .
- C. Power Driven Fasteners: National Evaluation Report NER-2 2.
- D. Wood Screws: ANSI B1 . .1. Provide flat washers at all attachments of hardboard panels.

- E. Lag Bolts: ANSI B1 .2.1.
- F. Bolts: Steel bolts complying with ASTM A 30 , Grade A with ASTM A 3 hex nuts and where indicated, flat washers.

2. METAL FRAMING ANCHORS

- A. General: Provide metal framing anchors of type, size, metal, and finish indicated that comply with requirements specified including the following:
 - 1. Current Evaluation/Research Reports: Provide products for which model code evaluation/research reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with the building code in effect for this Project.
 - 2. Allowable Design Loads: Provide products for which manufacturer publishes allowable design loads that are determined from empirical data or by rational engineering analysis and that are demonstrated by comprehensive testing performed by a qualified independent testing laboratory.

2. WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWWA U1 Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat the following:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing.
 - 2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
 - 3. Wood framing and furring attached directly to the interior of below-grade concrete walls.
 - 4. Wood floor plates that are installed over concrete slabs-on-grade.

2.9 FIRE-RETARDANT TREATMENT BY PRESSURE PROCESS

- A. General: Where fire-retardant-treated wood is required by an assembly, pressure impregnate lumber and plywood with fire-retardant chemicals to comply with AWWA C20.
 - 1. Interior Type A: For interior locations, including backing boards for electrical or communications equipment.
 - 2. Inspect each piece of treated lumber or plywood after drying and discard damaged or defective pieces.

PART 3 - EXECUTION

3.1. INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction scribe and cope as needed for accurate fit. Locate nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated. All nailing shall be according to Table 2304.9.1 of the International Building Code.
- C. Discard units of material with defects that impair quality of rough carpentry construction and that are too small to use in fabricating rough carpentry with minimum joints or optimum joint arrangement.
- D. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
- E. Do not splice structural members between supports, unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1) Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
- G. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

Use inorganic boron for items that are continuously protected from liquid water.
- I. Sills: Set all sill plates on continuous foam sill sealer.
- J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-2 2 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - A. Fit rough carpentry to other construction scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

- B. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated. Provide sill gaskets at all sill plates on slab.
- C. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood predrill as required.

3.2 WOOD GROUNDS, NAILERS AND BLOCKING

- A. Install wood grounds, nailers and blocking where shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.
- B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Where possible, anchor to formwork before concrete placement.

3.3 INSTALLATION OF CONSTRUCTION PANELS

- A. General: Comply with applicable recommendations contained in Form No. E30, "APA Design/Construction Guide - Residential Commercial," for types of construction panels and applications indicated.
- B. Fastening Methods: Fasten construction panels as shown on structural and indicated below:
 - 1. Plywood Backing and Wall Panels: Screw to supports.
 - 2. Plywood Ceiling Panels: Screw to supports.

END OF SECTION 0 1000

SECTION 072100 - INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Extent of insulation work is shown on drawings and indicated by provisions of this section.
- B. Applications of insulation specified in this section include the following:
 - 1. Blanket-type building insulation under roof deck or in perimeter/exterior walls.
 - 2. Rigid insulation.
- C. Section 0 2 00 Air Barrier (Building Wrap)
- D. Non-load bearing interior steel studs, drywall, and acoustical batts Section 092900 Gypsum Drywall Systems.

1.2 SUBMITTALS: Submit manufacturer's product data and installation instructions for each type of insulation product.

- A. Submit nailing pattern for composite insulation board.

1.3 PRODUCT HANDLING: Store insulation in undamaged original packaging and do not allow dirt or moisture pickup.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. BATT INSULATION UNDER ROOF DECK OR IN PERIMETER WALLS:

- 1) Glass Fiber Blanket/Batt Insulation: Inorganic (nonasbestos) fibers formed with binders into resilient flexible blankets or semi-rigid batts containing no formaldehyde ASTM C , densities of not less than 0. lb. per cu. ft., k-value of 0.2 manufacturer's standard lengths and widths as required to coordinate with spaces to be insulated.

Products: Johns Manville, Certainteed

- 2) Glasswool insulation blankets, manufactured with renewable organic binders (non phenol, formaldehyde, acrylics, or artificial colors), and high-recycled content fiberglass.

Product: Knauf Building Insulation Ecobatt Unfaced.

3) Under Low Slope Roof Deck: 12 to provide minimum R3 .

- a. At concealed spaces (above ceilings) or where exposed above drywall partitions provide FSK 2 foil/kraft facing.

4) In Perimeter Walls: 3-1/2 to provide minimum of R13.

B. RIGID INSULATION: Aluminum-faced polyisocyanurate foam insulation board, ASTM C129 Type I, Class 2. Meets IBC/IRC requirements for foam plastic insulation. See ICC-ES ESR-19, FM 400 see Factory Mutual Approval Guide. UL Classified. Calif. Std. Reg. CA T33. Miami-Dade NOA 00320.01 DOT Docket 90 Mass Transit Vehicle Insulation.

- 1. Thickness: 1 for R thermal insulation value.
- 2. Equal Dow Thermax Sheathing.

2.2 AUXILIARY INSULATING MATERIALS:

A. Mechanical Anchors: Type and size as recommended by particular insulation manufacturer for each type of application and condition of substrate.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION:

- A. Installer shall examine substrates and conditions under which insulation work is to be performed. Obtain Installer's written report listing conditions detrimental to performance of work in this section. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.
- B. Clean substrates of substances harmful to insulations.

3.2 INSTALLATION, GENERAL:

- A. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with work.
- B. Extend insulation full thickness as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.
- C. Apply a single layer of insulation of required thickness, unless shown as multiple layers.

3.3 INSTALLATION OF GENERAL BUILDING INSULATION:

- A. Batt Insulation: Fit units snugly between supports and fasten as required to maintain in place until covered by other materials.

- 1) Above perimeter furring to roof deck, studs may be discontinued and batts pinned through rigid insulation to wall.
 - B. Set faced units with face to interior side of construction. Edges of units shall be tight against support. Do not obstruct ventilation spaces, except for firestopping. Tape all joints, gaps, and penetrations in facing.
 - C. Stuff loose glass fiber insulation into all miscellaneous voids and cavity spaces. Compact to approximately 40% of normal maximum volume.
 - D. Rigid Insulation: Butt units lightly together fastening to sheathing as recommended by manufacturer of insulation. Fill all gaps with small pieces of insulation and trim neatly around penetrations. Tape all joints with aluminum faced tape.
- 3.4 PROTECTION: Protect installed insulation from weather exposure and physical abuse. Tape all tears in facings with matching tape. Temporarily seal exposed edges of composite insulation at the end of the day.
- A. Replace all insulation that has become wet or damaged.

END OF SECTION 0 2100

SECTION 072700 - AIR BARRIER (BUILDING WRAP)

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section includes the following:
 - 1. Mechanically attached flexible sheet air barrier (building wrap) at metal panel installation areas.
 - 2. Materials to bridge and seal the following air leakage pathways and gaps:
 - a. Connections of the walls to the roof air barrier.
 - b. Expansion joints.
 - c. Openings and penetrations of window frames, storefront.
 - d. Door frames.
 - e. Piping, conduit, duct and similar penetrations.
 - f. Masonry ties, screws, bolts and similar penetrations.
 - g. All other air leakage pathways in the building envelope.
- B. Related Work in other Sections includes the following:
 - 1. Section 0 1000 Rough Carpentry, for requirements that backup sheathing has been installed.

1.2 PERFORMANCE REQUIREMENTS

- A. Material Performance: Provide air barrier materials which have an air permeance not to exceed 0.004 cubic feet per minute per square foot under a pressure differential of 1. pounds per square foot 1. psf, when tested in accordance with ASTM E21 (unmodified).
- B. The water vapor permeance Desiccant method, (Procedure A) and Water method (Procedure B) shall be determined in accordance with ASTM E9 and shall be declared by the material manufacturer.
- C. Assembly Performance: Provide a continuous air barrier in the form of an assembly that has an air leakage not to exceed 0.04 cubic feet per minute per square foot under a pressure differential of 1. pounds per square foot (0.04 cfm/ft² 1. psf) when tested in accordance with ASTM E23 . The assembly shall accommodate movements of building materials by providing expansion and control joints as required. Expansion / control joints, changes in substrate and perimeter conditions shall have appropriate accessory materials at such locations.
 - 1. The air barrier assembly shall be capable of withstanding combined design wind, fan and stack pressures, both positive and negative on the envelope without damage or displacement, and shall transfer the load to the structure.
 - 2. Materials of the air barrier assembly shall not displace adjacent materials in the assembly under full load.
 - 3. The air barrier assembly shall be joined in an airtight and flexible manner to the air barrier materials of adjacent assemblies, allowing for the relative movement of assemblies due to thermal and moisture variations, creep, and anticipated seismic movement.

- D. Connections to Adjacent Materials: Provide connections to prevent air leakage at the following locations:
1. Foundation and walls, including penetrations, ties and anchors.
 2. Walls, windows, doors.
 3. Different assemblies and fixed openings within those assemblies.
 4. Wall and roof connections.
 - . Walls across construction, control and expansion joints.
 - . Wall utility, pipe and duct penetrations.
 - . Expansion joints.
 - . All other potential air leakage pathways in the building envelope.

1.3 SUBMITTALS

- A. Submittals: Submit in accordance with Division 1 requirements.
- B. Submit product data and installation instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original packages with seals unbroken, labeled with the material manufacturer's name, product, date of manufacture, and directions for storage.
- B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by Mechanically Attached Flexible Sheet Air Barrier Manufacturer. Protect stored materials from direct sunlight.
- C. Handle materials in accordance with material manufacturer s recommendations.

1. PROJECT CONDITIONS

- A. Temperature: Install Mechanically Attached Flexible Sheet Air Barriers within range of ambient and substrate temperatures recommended by the primary air barrier manufacturer. Do not apply air barrier to a damp or wet substrate.
- B. Field Conditions: Do not install air barrier in rain, fog, or mist. Do not install air barrier when the temperature of substrate surfaces and surrounding air temperatures are below those recommended by the primary material manufacturer.
- C. Sequencing. Do not install air barrier material before the roof assembly has been sufficiently installed to prevent a buildup of water in the interior of the building
- D. Compatibility. Do not allow mechanically attached flexible sheet air barriers to come in contact with chemically incompatible materials.
- E. Ultra-violet exposure. Do not expose air barrier materials to sunlight longer than as recommended by the primary material manufacturer

1. WARRANTY

- A. Material Warranty: Provide primary material manufacturer's standard product warranty, for a minimum TWO (2) years from date of Substantial Completion.

PART 2 - MATERIALS

2.1 AIR BARRIER MATERIALS:

- A. Mechanically Attached Flexible Sheet Air Barriers: Air Barrier. Subject to compliance with requirements, provide one of the following:
1. Basis of Design Material: DuPont Tyvek Commercial Wrap D by DuPont Weatherization Systems: www.tyvek.com
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - i. Air permeance for this material has been tested and reported as being 0.0004 cubic feet per minute per square foot when tested in accordance with ASTM E21 (unmodified).
 - ii. The water vapor permeance for this material has been tested and reported as being 243 nanograms per second per square meter divided by the pascals of vapor pressure per when tested in accordance with ASTM E9 (desiccant method - unmodified).
 - iii. The water vapor permeance for this material has been tested and reported as being 242 nanograms per second per square meter divided by the pascals of vapor pressure per meter when tested in accordance with ASTM E9 (water method - unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS: Tape, fasteners and sealers as recommended by manufacturer of primary material.
 2. Material: GreenGuard MAX Building Wrap by Pactiv Building Products:
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - i. Air permeance for this material has been tested and reported as being 0.0002 cubic feet per minute per square foot under a pressure differential of 1. pounds per square foot when tested in accordance with ASTM E21 (unmodified).
 - ii. The water vapor permeance for this material has been tested and reported as being 3 nanograms per second per square meter divided by the pascals of vapor pressure per meter when tested in accordance with ASTM E9 (desiccant method - unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS: As recommended by manufacturer of primary materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The Contractor shall examine substrates, areas, and conditions under which the air barrier assembly will be installed for compliance with the following requirements.
1. Verify that surfaces and conditions are suitable prior to commencing work of this section. Do not proceed with installation until unsatisfactory conditions have been corrected.
 2. Verify substrate is visibly dry.
 3. Ensure that the following conditions are met:
 - a. Surfaces are sound, dry, even, and free of excess mortar or other contaminants.
 - b. Inspect surfaces to be smooth without large voids or sharp protrusions. Inform General Contractor if substrates are not acceptable and need to be repaired by the concrete sub-trade.
 4. Verify sealants are compatible with flexible sheet air barrier proposed for use.
 - . Notify Architect in writing of anticipated problems installing the air barrier material over substrate prior to proceeding.

3.2 INSTALLATION

- A. Installation instructions for Mechanically Attached Flexible Sheet Air Barrier: Install flexible sheet air barrier in a way that provides continuity throughout the building envelope. Install materials in accordance with manufacturer's instructions and the following (unless manufacturer requires other procedures in writing based on project conditions or particular requirements of their recommended materials):
1. Install the head flashing material over all doors and windows which will be later covered by the air barrier material for proper drainage of water away from the window.
 2. Install building wrap over backup sheathing board, SIPS panels, or other fully-supported continuous substrates as per manufacturer's instructions.
 3. Begin by aligning the bottom edge of the roll approximately 4 inches below the base of the wall onto the foundation, approximately 24 inches from a corner, with the print side facing out. Fold greater than 4 inches of material under itself and fasten securely to a stud, structural sheathing or through insulation board to an underlying framing member.
 4. Ensure air barrier material is plumb and level on foundation, and unroll extending over window and door openings.
 - . Ensure air barrier material is applied over back edge of weep screed for proper water drainage.
 - . Unroll the air barrier material with the printed side facing out, wrapping the entire building, including door and window openings.
 - . Attach into wood stud framing, through insulated sheathing board or into metal stud framing with plastic cap nails or fasteners specified by air barrier material manufacturer. The fasteners must penetrate the framing member a minimum of 1/2 inch on every vertical stud line.
 - . Fasteners need to be installed along every stud or over SIPS panels vertically and 12" or closer together as specified by the material manufacturer apart horizontally to maintain integrity of air barrier assembly to ensure the material is fastened to building when negative and positive pressures are exerted.
 9. Install with drainage plane surface pattern in horizontal position. Install lower level air barrier material ensuring the upper layers of air barrier material lap the bottom layer to ensure proper shingling and water drainage.

10. Overlap at all corners of building by a minimum of 12 inches.
11. Overlap vertical seams by a minimum of 4 inches.
12. Prepare each window and door rough opening as recommended by the air barrier manufacturer or prepare by cutting a modified T pattern and wrap excess material to the inside of the rough opening and fasten securely to a framing member. At the window header, make a 45 degree diagonal cut at the corners of the air barrier and fold the material up above the rough opening, exposing the underlying sheathing. If windows are already in place when installing air barriers, trim as close to them as possible and tape all edges with manufacturer approved sealant tape. Use of window flashing materials is required as described in the International Building Code.
13. Detail remaining terminations and penetrations with accessory materials as per manufacturer's instructions for air leakage and ensuring lapping of the material for proper shingling and drainage of bulk water.
14. When the end of a roll is reached, fold the edge of the building wrap under itself and attach to the structural sheathing or through non-structural sheathing to the nearest framing member.
 1. Tape all horizontal and vertical seams with manufacturer approved construction tape.
 1. Seal top and bottom edges of rolled out material to substrate with manufacturer approved construction tape.
 1. Seal all tears and cuts with manufacturer approved construction tape.

3.3 PROTECTING AND CLEANING

- A. Protect air barrier materials from damage during installation and the remainder of the construction period, according to primary material manufacturer's written instructions.
 1. Coordinate with installation of materials which cover the air barrier assemblies, to ensure exposure period does not exceed that recommended by the air barrier material manufacturer.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction and acceptable to the primary material manufacturer.

END OF SECTION

SECTION 07 112 - METAL WALL PANELS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Preformed, prefinished metal wall panels and flashings to match existing (campus standard throughout).
- B. Miscellaneous trim, flashing, closures, drip flashing, and accessories.
- C. Fastening devices.

1.02 RELATED SECTIONS

- A. Section 0 1000 Rough Carpentry for sheathing.
- B. Section 0 2 00 Air Barrier.

1.03 REFERENCES

- A. American Iron Steel Institute (AISI) Specification for the Design of Cold formed Steel Structural Members.
- B. ASTM 92- AZ- 0 Aluminum Zinc Alloy Coated Steel (Galvalume Sheet Metal)
- C. Spec Data Sheet - Aluminum Zinc Alloy Coated Steel (Galvalume) Sheet Metal by Bethlehem Corp.
- D. SMACNA - Architectural Sheet Metal Manual.

1.04 ASSEMBLY DESCRIPTION

- A. Assembly includes preformed sheet metal panels, miscellaneous flashing and attaching devices.

1.0 SUBMITTALS

- A. Submit detailed drawings showing layout of panels, anchoring details, joint details, trim, flashing, and accessories. Show details of weatherproofing, terminations, and penetrations of metal work.
- B. Submit a sample of each type of panel, complete with factory finish to match existing.

1.0 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in Architectural Sheet Metal Products with ten (10) years minimum experience.

1.0 DELIVERY, STORAGE AND HANDLING

- A. Upon receipt of panels and other materials, installer shall examine the shipment for damage and completeness.
- B. Panels should be stored in a clean, dry place. One end should be elevated allowing moisture to run off.

- C. Panels with strippable film must not be stored in the open, exposed to the sun.
- D. Stack all materials to prevent damage and to allow adequate ventilation.

1.0 WARRANTY

- A. Paint finish shall have a twenty-year warranty against cracking, peeling and fading (not to exceed N.B.S. units).
- B. Galvalume material shall have a twenty-year warranty against failure due to corrosion, rupture or perforation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS include but are necessarily limited to:

- AARA
- ATAS
- Metal Sales
- MBCI
- Roll Fab

2.02 SHEET MATERIALS

- A. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 92/A 92M, structural quality, Grade 0, Coating Class AZ 0 (Grade 340, Coating Class AZM1 0), prepainted by the coil-coating process per ASTM A 92/A 92M.
- B. Nominal Thickness: 24 gage, with stucco embossed surface.
- C. Exterior Finish: Fluoropolymer two-coat system.
- D. Color: To closely match existing building color verify in field (deep blue).
- E. Panel Width: 12 inches.
- F. Panel Thickness: 1-1/2 inch.
- G. Strippable film shall be applied to the top side of all prefinished metal to protect the finish during fabrication, shipping and field handling. This strippable film SHALL be removed immediately before installation and shall NOT be exposed to direct sunlight any longer than necessary.
- H. Field protection must be provided by the contractor at the job site so stacked or coiled material is not exposed to weather and moisture.
- I. Flashing maybe factory fabricated or field fabricated. Unless otherwise specified all exposed adjacent flashing shall be of the same material and finish as panel system.

2.03 ACCESSORY MATERIALS

- A. Fasteners: Galvanized steel with washers where required.
- B. Sealant: As specified in Section 0 9200 Joint Sealers.

2.04 FABRICATION

- A. All exposed adjacent flashing shall be of the same material and finish as the wall panels.
- B. Hem all exposed edges of flashing on underside, inch.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Substrate
 - 1. Verify that air barrier installation is complete and all flashings, terminations, and joints properly installed.

3.02 INSTALLATION

- A. Comply with manufacturers standard instructions and conform to standards set forth in the Architectural Sheet Metal Manual published by SMACNA, in order to achieve a watertight installation.
- B. Install panels in such a manner that horizontal lines are true and level and vertical lines are plumb.
- C. Install starter and edge trim before installing panels.
- D. Remove protective strippable film prior to installation of panels.
- E. Attach panels using manufacturer s standard clips and fasteners, spaced in accordance with approved shop drawings.
- F. Do not allow panels or trim to come into contact with dissimilar materials.
- G. Remove and replace any panels or components which are damaged beyond successful repair.

3.03 CLEANING

- A. Clean any grease, finger marks or stains from the panels per manufacturer s recommendations.
- B. Remove all scrap and construction debris from the site.

END OF SECTION

SECTION ROOF HATCH

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof hatch with safety pole and guard rail with gate.
- B. Alternating tread ladder is specified in Section 0 000 Metal Fabrications.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified. Submit manufacturer's detailed technical product data, installation instructions and recommendations, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

1.4 QUALITY ASSURANCE

- A. Standards: Comply with the following:
 - 1. SMACNA "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap-flashing to coordinate with type of roofing indicated.
 - 2. NRCA "Roofing and Waterproofing Manual" details for installation of units.
- B. PERFORMANCE REQUIREMENTS: General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

C. COORDINATION

- a. Coordinate layout and installation of roof accessories with roofing system and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Commercial-Quality Galvanized Steel Sheet: ASTM A 2 with G90 coating complying with ASTM A 2 .
- B. Insulation: Manufacturer's standard rigid or semirigid glass-fiber board of thickness indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with water-borne preservatives for above-ground use, complying with AWPA C2 not less than 1-1/2 inch thick.
- D. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.
 1. Where removal of exterior exposed fasteners affords access to building, provide nonremovable fastener heads.
- E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene or polyvinyl chloride, or block design of sponge neoprene.
- F. Bituminous Coating: SSPC-Paint 12, solvent-type bituminous mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 1 -mil dry film thickness per coating.
- G. Mastic Sealant: Polyisobutylene nonhardening, nonskinning, nondrying, nonmigrating sealant.
- H. Elastomeric Sealant: Generic type recommended by unit manufacturer that is compatible with joint surfaces ASTM C 920, Type S, Grade NS, Class 2 , and Uses NT, G, and, A.
- I. Roofing Cement: ASTM D 4 , nonasbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

2.2 FINISHES

- A. General: Comply with NAAMM "Metal Finishes Manual" for recommendations on applying and designating finishes.
- B. Baked Enamel Primer Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.

2.3 ROOF HATCH

- A. General: Fabricate units to withstand 40-lbf per sq. ft. external loading and 20-lbf per sq. ft. internal loading pressure. Frame with 9-inch-high, integral-curb, double-wall construction with 1-1/2 inch insulation, cant strips and cap flashing (roofing counterflashing), with welded or sealed mechanical corner joints. Provide double-wall cover (lid) construction with 1 inch insulation core. Provide gasketing and equip corrosion-resistant or hot-dip galvanized hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.
- B. Type: Single-leaf personnel access.
 - 1. 3 x 3
Product equal of Nystrom Personnel II (RHU) G3 x3
- C. Material: Zinc-coated steel sheets, 14 ga. primed with standard color factory applied polyester powder coat finish.
- D. Safety Accessory: Provide extendable safety pole attached at top of ladder. Painted steel, 42 . Equal Nystrom SP.
- E. Safety Rail: Provide screw-on safety rail with gate, aluminum with safety yellow powder coat, equal Nystrom SRC.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's instructions and recommendations. Coordinate with installation of roof deck to ensure that hatch performs properly. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses, as well as inward and outward loading pressures.
 - 1. Install roof accessory items according to construction details of NRCA "Roofing and Waterproofing Manual" and with details shown on drawings.

- B. Isolation: Where metal surfaces of units are to be installed in contact with incompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.
- C. Flange Seals: Set flanges of accessory units in a thick bed of roofing cement to form a consistent seal.
- D. Cap Flashing: Where cap flashing is required as component of accessory, install to provide adequate waterproof overlap with roofing or roof flashing (as counterflashing). Seal with thick bead of mastic sealant, except where overlap is indicated to be left open for ventilation.
- E. Operational Units: Test operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

3.2 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces according to manufacturer's instructions. Touch up damaged metal coatings.

END OF SECTION 0 200

SECTION STEEL HOLLO METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following products manufactured in accordance with SDI Recommended Standards:
 - 1. Doors: Steel doors for interior and exterior locations, some with louvers.
 - 2. Frames: Hollow metal frames for doors, sidelights, borrowed lights, windows, storefront framing, and other interior and exterior openings of following type:
 - a. Welded unit type.
 - 3. Provide factory primed doors and frames to be field painted.
- B. Section 0 9200 Joint Sealers.
- C. Section 0 100 Finish Hardware and Hardware Schedule.
- D. Section 0 000 Glazing.

1.3 SUBMITTALS

- A. Product data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, profiles, and finishes.
- B. Shop drawings showing fabrication and installation of standard steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.
 - 1. Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.
 - 2. Indicate coordinate of glazing frames and stops with glass and glazing requirements.

- 1.4 **QUALITY ASSURANCE:** Provide doors and frames complying with Steel Door Institute "Recommended Specifications Standard Steel Doors and Frames" ANSI/SDI-100 and as herein specified.

1. DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
- B. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect otherwise, remove and replace damaged items as directed.
- C. Store doors and frames at building site under cover. Place units on minimum 4-inches high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4" spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 9 and ASTM A .
- B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 3 and ASTM A .
 - 1. Exterior Doors, Frames and Framing: Provide with metallic coating conforming to ASTM A924 for hot dip galvanization.
- C. Supports and Anchors: Fabricate of not less than 1 -gage sheet steel. For anchorage to steel stud partitions provide anchors welded to frame.
- D. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize in compliance with ASTM A 1 3, Class C or D as applicable.
- E. Shop Applied Paint: Apply after fabrication.
 - 1. Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints complying with ANSI A224.1, "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."

2.2 DOORS

- A. Provide metal doors of SDI grades and models specified below:
 - 1. ANSI/SDI-100
 - a. Exterior Doors: Grade III, extra heavy-duty, minimum 1 -gage cold-rolled sheet steel faces. Provide seamless faces with edge seams welded and ground. Exterior doors shall have polystyrene foam infill and shall be additionally reinforced for all applied hardware. Minimum " top rail with seamless top channel caps.

- b. Interior Doors: Grade II, heavy-duty, minimum 1 ga. cold-rolled steel faces. Provide seamless faces with edge seams welded and ground. Interior doors shall have resin-impregnated honeycomb core and shall be additionally reinforced for all applied hardware.

Reinforce vertical edges with minimum 1 ga. x 1" channels with 1" returns.

- 1) Glass stops shall be 1 ga. steel channels, factory installed and through-fastened with countersunk flathead machine screws.
- c. Provide inverted bottom closure channel for all doors.
- d. Lock and hinge stiles shall be accurately mortised and reinforced to receive scheduled hardware. Reinforcement shall be not less than 3/16" thick steel drilled and tapped to receive hinges and locks. From the top edge of all doors and located 3" from the top, install a 1" x 14 ga. channel to separate the faces of the door, and two reinforcing plates 22" x 4. 1/2" x 12 ga. to suit closers. Install spreaders for panic hardware which requires through-bolts. Reinforce for push plates, escutcheons, and similar items with 14 ga. sheet.
- e. Louvers: Provide louvers for exterior doors, where indicated, which comply with SDI 111, with blades or baffles formed of 0.020-inch-thick, cold-rolled steel sheet set into 0.032-inch-thick steel frame.

Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.

2.3 FRAMES

- A. Provide metal frames for flush wood and steel doors, sidelights, borrowed lights, interior and exterior windows, and other openings, of types and styles as shown on drawings and schedules. Conceal fastenings, unless otherwise indicated.
1. Fabricate frames with mitered or coped corners, welded construction for all applications.
 2. Form all exterior door frames from 16-gage steel and all interior frames from 14 ga. steel.
 3. Provide 4 wall anchors per jamb, plus a floor anchor, with mortar boxes for all hardware, 14 ga.
 4. All rabbets shall be sized and hinge preparations performed to accommodate seals and gaskets (to allow doors to close properly).
- B. Door Silencers: Except on weatherstripped frames or frames with smoke or sound seals, drill stops to receive 3 silencers on strike jambs of single-door frames and 2 silencers on heads of double-door frames.

2.4 FABRICATION

- A. Fabricate steel door and frame units 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/SDI-100 requirements.

1. Clearances: Not more than 1/4 inch at jambs and heads 3/4" at sill to allow for " threshold and door shoe.
- B. Fabricate exposed faces of doors and panels from only cold-rolled steel.
- C. Tolerances: Comply with SDI 11 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot-rolled steel.
- E. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
- F. Hardware Preparation: Prepare doors and 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 A11 Series Specifications for door and frame preparation for hardware.
- G. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at project site.
- H. Locate hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames," published by Door and Hardware Institute.
- I. Shop Painting: Clean, treat, and paint exposed surfaces of steel door and frame units.
 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 finish paint.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install steel doors, frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.
- B. Placing Frames: Comply with provisions of SDI-10 "Recommended Erection Instructions For Steel Frames," unless otherwise indicated.
 - 1) In metal-stud partitions, provide at least three wall anchors per jamb install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.

- C. Door Installation: Fit hollow metal doors accurately in frames, within clearances specified in ANSI/SDI-100. Install glass in doors. Screws on stops shall be tamperproof and toward exterior on exterior doors.

3.2 ADJUST AND CLEAN

- A. Prime Coat Touch-up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Final Adjustments: Check and readjust operating hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

END OF SECTION 0 1113

SECTION 081 16 FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

- A. Extent and location of each flush wood door is indicated on drawings and in schedules.
- B. Type of doors required is the following:
 - 1. Solid core flush wood doors with wood veneer faces.
- C. Shop-priming, factory-finishing, and factory-premachining for hardware for wood doors is included in this section.
- D. Section 0 1113 Steel Doors and Frames.
- E. Section 11 310 Laboratory Casework and Other Furnishings. Wood doors and laboratory casework finishes shall match. GC shall coordinate.

1.3 SUBMITTALS:

- A. Product Data: Door manufacturer's technical data for each type of door, including details of core and edge construction, trim for openings and louvers, and factory-finishing specifications.
- B. Shop Drawings: Submit shop drawings indicating 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 pertinent data.
- C. Samples: Submit 3 samples of specified veneer with finish, or range of finish variation, to be anticipated on doors, 1-0" square for factory-finished doors.

1.4 QUALITY ASSURANCE:

- A. Quality Standards: Comply with the following standards:
 - 1. NWWDA Quality Standard: I.S.1 "Industry Standard for Wood Flush Doors", of National Wood Window and Door Association (NWWDA).
 - 2. Architectural Woodwork Institute and Woodwork Institute Architectural Woodwork Quality Standards latest edition.

- B. NWWMA Quality Marking: Mark each wood door with NWWDA Wood Flush Door Certification Hallmark certifying compliance with applicable requirements of NWWDA I.S. 1 Series.
 - 1. For manufacturers not participating in NWWDA Hallmark Program, a certification of compliance may be substituted for marking of individual doors.
- 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING: Protect doors with plastic bags during transit, storage and handling to prevent damage, soiling and deterioration. Comply with requirements of referenced standards and recommendations of NWWDA pamphlet "How to Store, Handle, Finish, Install, and Maintain Wood Doors", as well as with manufacturer's instructions.
- 1. PROJECT CONDITIONS: Conditioning: 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 remainder of construction period to comply with the following requirements applicable to project's geographical location:
 - 1. WARRANTY:
 - A. General: Warranties shall be in addition to, and not a limitation of, other rights the Owner may have under the Contract Documents.
 - B. Door Manufacturer's Warranty: Submit written agreement in door manufacturer's standard form signed by Manufacturer, Installer and Contractor, agreeing to repair or replace defective solid core interior doors that have warped (bow, cup or twist) or that show telegraphing of core construction in face veneers, delamination, or do not conform to tolerance limitations of referenced quality standards.
 - 1. Warranty shall also include reinstallation and refinishing which may be required due to repair or replacement of defective doors where defect was not apparent prior to hanging.
 - 2. Warranty shall be in effect during following period of time after date of Substantial Completion: Lifetime of installation.

PART 2 - PRODUCTS

2.1 INTERIOR FLUSH WOOD DOORS:

- A. Solid Core Doors for Transparent Finish: Comply with the following requirements:
 - 1. Faces: Plain sawn Select White Maple.
 - 2. AWI Grade: A
 - 3. Match between Veneer Leaves: Book match.
 - 4. Assembly of Veneer Leaves on Door Faces: Balance match.

- . Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
- . Room Match: Match door faces within each separate room or area of building. Corridor door faces do not need to match where they are more than 20' apart.
- . Construction: PC- (Particleboard core, -ply faces), with stiles and rails glued to core and sanded before laminating, and all doors assembled with Type I adhesive. Provide solid wood blocking for closers, exit devices, and locksets. Stiles and rails shall be of solid hardwood, 1-1/2" minimum for rails, 1-3/4" minimum for stiles. Surrounds for light openings shall be compatible hardwood, 1/2" minimum on all sides.

2.2 FABRICATION:

- A. Fabricate flush wood doors to produce doors complying with following requirements:
 - 1. In sizes indicated for job-site fitting.
 - 2. Doors shall be machined for hardware at the site.
- B. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of doors required.

2.3 FACTORY FINISHING:

- A. General: Comply with referenced Woodwork Standards Section 2805.10 Finishing to prefinish wood doors at factory.
- B. Transparent Finish: Comply with requirements indicated for grade, finish system, staining effect and sheen. Finish all surfaces of doors. Reseal all surfaces cut or trimmed after finishing doors.
 - 1. Grade: Custom.
 - 2. Factory finish doors in accordance with WDMA I.S.1A or AWS Quality Standards. Factory finish to be water based stain with ultraviolet (UV) cured polyurethane sealer. Finish must meet or exceed performance standards of UV cured polyurethane (TR-9000) or (System 9).
 - 3. Staining: To match finish selected for maple lab casework.
 - 4. Effect: Close grain finish.
 - . Sheen: Satin-medium rubbed effect (30 deg. gloss).

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine installed door frames prior to hanging door:
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.

2. Reject doors with defects.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. Hardware: Coordinate with Section 0 100 - Finish Hardware.

B. Manufacturer's Instructions: Install wood doors in HM frames to comply with manufacturer's instructions and of referenced AWI standard and as indicated.

C. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal all cut surfaces after fitting and machining (including cutouts, edges, tops and bottoms of doors).

1. Fitting Clearances for Doors: Provide 1/8" at jambs and heads 1/16" per leaf at meeting stiles for pairs of doors and 1/8" from bottom of door to top of floor finish. Where threshold is shown or scheduled, provide 1/4" clearance from bottom of door to top of threshold. Comply with NFPA 0 for fire-rated doors.

D. Factory-Finished Doors: Restore finish before installation as required. The Owner will not accept doors which show signs of repair. Seal all edges or penetrations cut after finishing or in the field using a VOC compliant sealer.

3.3 ADJUSTING AND PROTECTION:

A. Operation: Rehang or replace doors which do not swing or operate freely.

B. Finished Doors: Refinish or replace doors damaged during installation.

C. Protect doors and panels as recommended by manufacturer to ensure that they will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 0 141

SECTION 0 44 - AL MIN M DOORS ENTRANCES AND FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of exterior aluminum entrance and framing work:
 - 1. Swing doors exterior.
 - 2. Frames for entrances.
 - 3. Thermally-improved storefront-type framing systems for openings.
 - 4. Factory finishing for aluminum.

Brake metal sections to match other aluminum framing.

- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Joint sealers are specified in Section 0 9200.
 - 2. Door hardware (aside from weatherstripping) is specified in Section 0 100 Finish Hardware.
 - 3. Glazing requirements for aluminum entrances, storefront and sliding entrances are included in Section 0 000 - Glazing.

1.3 FRAMING SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum doors, entrances and storefront assemblies that comply with performance characteristics specified, as demonstrated by testing the manufacturer's corresponding stock assemblies according to test methods indicated.
- B. Thermal Movement: Design the aluminum entrance and storefront framing systems to provide for expansion and contraction of the component materials. Entrance doors shall function normally over the specified temperature range.
 - 1. The system shall be capable of withstanding a metal surface temperature range of 1 0 deg. F without buckling, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, stress on glass, or other detrimental effects.
- C. Design Requirements: Provide aluminum entrance and storefront systems that comply with structural performance, air infiltration, and water penetration requirements specified below.
 - 1. Wind Loads: Provide aluminum entrance and storefront assemblies capable of withstanding wind pressures of 20 psf inward and 20 psf outward acting normal to the plane of the wall.

- D. Structural Performance: Conduct tests for structural performance in accordance with ASTM E 330. At the conclusion of the tests there shall be no glass breakage or permanent damage to fasteners, anchors, hardware or actuating mechanism. Framing members shall have no permanent deformation in excess of 0.2 percent of their clear span.
1. Deflection Normal to the Plane of the Wall: Test pressure required to measure deflection of framing members normal to the plane of the wall shall be equivalent to the wind load specified above. Deflection shall not exceed $1/100$ of the clear span, when subjected to uniform load deflection test.
 2. Deflection Parallel to the Plane of the Wall: Test pressures required to measure deflection parallel to the plane of the wall shall be equal to 1.25 times the wind pressures specified above. Deflection of any member carrying its full dead load shall not exceed an amount that will reduce glass bite below 10 percent of the design dimension and shall not reduce the edge clearance between the member and the fixed panel, glass or other fixed member above to less than $1/8$ inch. The clearance between the member and an operable door or window shall be at least $1/8$ inch.
 3. The Manufacturer who supplies the project shall analyze system requirements, including configuration and height of members, and provide supplementary reinforcing for framing members as required to meet structural criteria.
- E. Air Infiltration: Provide aluminum entrance and framing systems with an air infiltration rate of not more than 0.05 CFM per sq. ft. of fixed area (excluding operable door edges) when tested at a test pressure of 0.24 PSF in accordance with ASTM E 283.
- F. Water Penetration: Provide framing systems with no uncontrolled water penetration (excluding operable door edges) as defined in the test method when tested in accordance with ASTM E 331 at an inward test pressure differential of
Storefront - 1.5 lb. per sq. ft.
- G. Overall U-Factor with 0.29 at COG - 0.3.
- H. Condensation Resistance Factor 9.

1.4 SWING DOOR PERFORMANCE REQUIREMENTS

- A. Structural: Resistance to corner racking shall be tested by the Dual Moment Load test as follows:
1. Test section shall consist of a standard top door corner assembly side rail shall be 24" long and top rail section shall be 12" long.
 2. Anchor top rail positively to test bench so that the corner protrudes 3" beyond the bench edge. Anchor a lever arm positively to the side rail at a point 19" from inside edge of the top rail. Attach weight support pad at a point 19" from inner edge of side rail.
 3. Test section shall withstand a load of 240 lbs. on the lever arm before reaching the point of failure, which shall be considered a rotation of the lever arm in excess of 4 deg.
- B. Air Infiltration for Doors: Air infiltration shall be tested in accordance with ASTM E 283, at a pressure differential of 1.5 psf. A single 30" x 0" entrance door and frame shall not exceed 0.05 CFM per linear foot of perimeter crack. A pair of 30" x 0" doors and frame shall not exceed 1.0 CFM per linear foot of perimeter crack.

1. SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.
1. Provide the following:
 - a. Manufacturer's standard details and fabrication methods.
 - b. Data on finishing, hardware and accessories. Provide paint finish samples to verify match to existing.
 - c. Recommendations for maintenance and cleaning of exterior surfaces.
 2. Shop drawings for each aluminum door, entrance, storefront system required, including:
 - a. Layout and installation details, including relationship to adjacent work.
 - b. Elevations at 1/4-inch scale.
 - c. Detail sections of typical composite members.
 - d. Section and elevation of shading fins.
 - e. Anchors and reinforcement.
 - f. Hardware mounting heights.
 - g. Provisions for expansion and contraction.
 - h. Glazing details.
 3. Hardware Schedule: Submit complete hardware schedule organized into sets based on hardware specified for each opening. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Include cut sheets with pictures, item name, name of the manufacturer and complete designations of every item required for each door opening.
 4. Samples: Submit samples of medium and dark bronze finishes x , 3 each, to verify finish against existing at site. Given the age of the building patina may have changed initial color.
 - . Test Reports: Provide certified test reports from a qualified independent testing laboratory showing that aluminum systems have been tested in accordance with specified test procedures and comply with performance characteristics indicated.

1. QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed installations of aluminum storefront and entrances similar in design and extent to those required for the project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer's Qualifications: Provide aluminum entrances and framing systems produced by a firm experienced in manufacturing systems that are similar and equal to those indicated for this project and that have a record of successful in-service performance.
- C. Design Criteria: The drawings and specifications indicate the size, profile, and dimensional requirements of aluminum entrance and framing work required, as well as all performance criteria, and are based on the specific types and models indicated. Aluminum entrance and storefront by other manufacturers may be considered, provided deviations in dimensions and profiles are minor and do not change the design concept as judged by the Architect, and another system meets all performance criteria. The burden of proof of equality is on the proposer.

1. DELIVERY, STORAGE, AND HANDLING

- A. Deliver aluminum entrance and framing components in the manufacturer's original protective packaging.
- B. Store aluminum components in a clean dry location away from uncured masonry or concrete. Cover components with waterproof paper, tarpaulins or polyethylene sheeting to permit circulation of air. Stack framing components to prevent bending and damage. Store hardware in a locked and secure location.

1. PROJECT CONDITIONS

- A. Field Measurements: If possible, check openings by accurate field measurement before fabrication. Show recorded measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of the work.
 - 1. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit.

1.9 WARRANTY

- A. Warranty: Submit a written warranty, executed by the manufacturer, agreeing to repair or replace units that fail in materials or workmanship within the specified warranty period. Failures include, but are not necessarily limited to:
 - 1. Structural failures including excessive deflection, excessive leakage or air infiltration.
 - 2. Deterioration of metals, metal finishes and other materials beyond normal weathering.
- B. Warranty Period: 2 years after the date of Substantial Completion.
- C. The warranty shall not deprive the Owner of other rights or remedies the Owner may have under other provisions of the Contract Documents, and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

- 2.1. MANUFACTURER: Provide framing and doors meeting plans and specifications manufactured by one of the following:

Arcadia
CLR/US Aluminum
Oldcastle BE
Kawneer
Trulite

2.2 MATERIALS

- A. Aluminum Members: 0 3-T alloy and temper comply with ASTM B 221 for aluminum extrusions, ASTM B 209 for aluminum sheet or plate, and ASTM B 211 for aluminum bars, rods and wire. Use same material for frames and subframes.
 - 1. Brake metal: 1/ aluminum, same alloy and temper as framing members.

- B. Carbon steel reinforcement of aluminum framing members shall comply with ASTM A 3 for structural shapes, plates and bars, ASTM A 11 for cold rolled sheet and strip, or ASTM A 10 for hot rolled sheet and strip.
- C. Glass and Glazing Materials: Comply with requirements of Section 05000 - Glass and Glazing for typical insulating glazing units and for laminated units for glazing at shade fins. Glaze aluminum systems with manufacturer's standard elastomeric glazing gaskets.
- D. Fasteners: Provide fasteners of aluminum, nonmagnetic stainless steel, zinc plated steel, or other material in accordance with ASTM A 194, warranted by the manufacturer to be noncorrosive and compatible with aluminum components, hardware, anchors and other components.
 - 1. Reinforcement: Where fasteners screw-anchor into aluminum members less than 0.12 inches thick, reinforce the interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard noncorrosive pressed-in splined grommet nuts.
 - 2. Exposed Fasteners: Do not use exposed fasteners except for application of hardware. For application of hardware, use Phillips flat-head machine screws that match the finish of member or hardware being fastened.
- E. Brackets and Reinforcements: Provide high-strength aluminum brackets and reinforcements where use of aluminum is not feasible provide nonmagnetic stainless steel or hot-dip galvanized steel complying with ASTM A 123.
- F. Concrete Inserts: Provide cast iron, malleable iron, or hot-dip galvanized steel inserts complying with ASTM A 123.
- G. Compression Weatherstripping for Heads and Jambs: Manufacturer's standard replaceable compressible weatherstripping gaskets of molded neoprene complying with ASTM D 2000 or molded PVC complying with ASTM D 2238.
- H. Door Bottom Weatherstripping: For each swing door provide center-mounted brush sweep (not vinyl).
- J. Glazing Gaskets: Compression-type design, replaceable, molded or extruded EPDM to suit system, UV and heat resistant. Shall lock securely into glazing reglet to prevent glazing gaskets from disengaging.

2.3 HARDWARE

- A. General: Refer to Section 05100 - Finish Hardware for requirements for hardware items other than those indicated to be provided by the aluminum entrance manufacturer.
- B. Provide heavy-duty hardware units as indicated, scheduled, or required for operation of each door, including the following items of sizes, number, and type recommended by manufacturer for service required finish all items in a Clear anodized finish or other finish to match US20 being used for remainder of finish hardware.

2.4 COMPONENTS

- A. Framing Systems: Provide framing systems fabricated from extruded aluminum members of size and profile indicated. Include subframes and reinforcing members of the type required or indicated. Shop-fabricate and preassemble frame components where possible.
 - 1. Storefront System: Nominal 4-1/2" deep X 2" wide two part front glaze typical, thermally improved.
 - 2. System shall drain to the exterior.
 - 3. System equal to Arcadia AFG4 1T Series Thermal - Screw Spline Front Glazed.
- B. Entrance Door Frames: Provide tubular and channel frame entrance door frame assemblies, as indicated, with welded or mechanical joints in accordance with manufacturer's standards. Reinforce as necessary to support required loads.
- C. Stile-and-Rail Type Swing Doors: Provide tubular frame members minimum .12 " thickness, fabricated with mechanical clip fastened joints, with SIGMA deep penetration and fillet welds with heavy inserted reinforcing plates.
 - 1. Glazing: Fabricate doors to facilitate replacement of glass, without disassembly of stiles and rails. Provide snap-on extruded aluminum glazing stops, .0 0" thickness, with exterior stops anchored for nonremoval. Glaze with insulated safety glazing units as specified in Section 0 000.
 - 2. Design: Provide 1-3/4-inch-thick doors of design indicated.
 - a. Wide stile
Vertical Stiles and Top Rail: Nominal
Bottom Rail: Minimum 10 for ADA compliance

2. FABRICATION

- A. General: Fabricate aluminum components to designs, sizes and thicknesses indicated and to comply with indicated standards. Sizes and profile requirements are indicated on the drawings. Variable dimensions are indicated, with maximum and minimum dimensions required, to achieve design requirements and coordination with other work.
- B. Prefabrication: Complete fabrication, assembly, finishing, hardware application, and other work to the greatest extent possible before shipment to the Project site. Disassemble components only as necessary for shipment and installation.
 - 1. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work to prevent damage to exposed finish surfaces. Complete these operations for hardware prior to application of finishes.
 - 2. Do not drill and tap for surface-mounted hardware items until time of installation at project site.
 - 3. Preglaze door and frame units to greatest extent possible.
- C. Welding: Comply with AWS recommendations. Grind exposed welds smooth to remove weld spatter and welding oxides. Restore mechanical finish.
 - 1. Welding behind finished surfaces shall be performed in such a manner as to minimize distortion and discoloration on the finished surface.

- D. Reinforcing: Install supplementary reinforcing as required for hardware and as necessary for performance requirements, sag resistance and rigidity.
- E. Dissimilar Metals: Separate dissimilar metals with bituminous paint, or a suitable sealant, or a nonabsorptive plastic or elastomeric tape, or a gasket between the surfaces. Do not use coatings containing lead.
- F. Continuity: Maintain accurate relation of planes and angles with hairline fit of contacting members.
 - 1. Uniformity of Metal Finish: Abutting extruded aluminum members shall not have an immediately perceptible color or texture variation.
- G. Fasteners: Conceal fasteners wherever possible.
- H. Weatherstripping: For exterior doors, provide compression weatherstripping against fixed stops. At other edges, provide sliding weatherstripping retained in adjustable strip mortised into door edge. Provide weatherstripping at bottom of door.

2. FINISHES

- A. General: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
- B. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
 - 1. Color Anodic Finish: AAMA 11, AA-M12C22A42/A44, Class I, 0.01 mm, or thicker.
Color: Dark bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and supports, with the Installer present, for compliance with requirements indicated, installation tolerances, and other conditions that affect installation of aluminum entrances and storefronts. Correct unsatisfactory conditions before proceeding with the installation.
 - 1. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations for installation.
- B. Set units plumb, level, and true to line, without warp or rack of framing members, doors, or panels. Install components in proper alignment and relation to established lines and grades indicated. Provide proper support and anchor securely in place.
- C. Construction Tolerances: Install aluminum entrances and framing to comply with the following tolerances:

1. Variation from Plane: Do not exceed 1/8 inch in 12 feet of length or 1/4 inch in any total length.
 2. Offset from Alignment: The maximum offset from true alignment between two identical members abutting end to end in line shall not exceed 1/16 inch.
 3. Diagonal Measurements: The maximum difference in diagonal measurements shall not exceed 1/8 inch.
 4. Offset at Corners: The maximum out-of-plane offset of framing at corners shall not exceed 1/32 inch.
- D. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
1. Zinc or cadmium plate steel anchors and other unexposed fasteners after fabrication.
 2. Paint dissimilar metals where drainage from them passes over aluminum.
 3. Paint aluminum surfaces in contact with mortar, concrete or other masonry with alkali resistant coating.
- E. Drill and tap frames and doors and apply surface-mounted hardware items. Comply with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.
- F. Thresholds: Set on concrete using appropriate expansion anchors. Grout cavity under all thresholds using a nonshrink grout during installation.
- G. Refer to Section 0 000 - Glazing for installation of glass and other panels indicated to be glazed into doors and framing, and not preglazed by manufacturer.
- 3.3 ADJUSTING: Adjust operating hardware and operators to function properly, for smooth operation without binding, and for weathertight closure.
- 3.4 CLEANING: Clean the completed system, inside and out, promptly after installation, exercising care to avoid damage to coatings. Clean glass surfaces after installation, complying with requirements contained in the Section 0 000 for cleaning and maintenance. Remove excess glazing and sealant compounds, dirt and other substances from aluminum surfaces.
3. PROTECTION: Institute protective measures required throughout the remainder of the construction period to ensure that aluminum entrances and storefronts will be without damage or deterioration, other than normal weathering, at time of acceptance.

END OF SECTION 0 4413

SECTION 087100 - FINISH HARDWARE AND HARDWARE SCHEDULE

PART 1 - GENERAL

- 1.1 **RELATED DOCUMENTS:** Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification sections, apply to work of this section.
- 1.2 **DESCRIPTION OF WORK:** Furnish all Finish Hardware and related items to complete work shown and specified. See drawings, schedules and details for items requiring hardware and for installation details.
- A. Provide all locksets less cylinder. Owner will provide temporary and permanent cylinders and all keying.
 - B. Aluminum Doors: Weatherstripping is specified in Section 0 4413 remainder of hardware for these doors is specified in this section (AL-XX).
 - C. Boxes and conduit for access control installation: Division 2 Electrical. Electric strikes are specified in this section. Card readers are by Owner.
- 1.3 **WORK EXCLUDED:** Items generally known as rough hardware, or items of Finish Hardware when noted elsewhere in the Specifications as being furnished or included with items by other suppliers or Contractors, are not included.
- 1.4 **QUALITY ASSURANCE:**
- A. **Manufacturer:** Obtain each kind of hardware from only one manufacturer, although several may be indicated as offering products complying with requirements.
 - B. **Supplier:** A recognized builders hardware supplier who has been furnishing hardware in the project's immediate vicinity for a period of not less than 2 years, and who is, or employs on a full time basis, a registered Architectural Hardware Consultant member of the Door and Hardware Institute to properly detail work, order materials, and supervise installation.
 - 1. The firm proposing to supply Finish Hardware for this project must be a regular stocking distributor of the hardware it proposes to furnish.
 - 2. The Hardware Supplier shall make periodic inspections of project (upon receipt of hardware at project, during installation and at completion of installation) so that at the completed installation, Supplier can certify that said hardware is properly installed according to manufacturer's printed instructions. Forward copy of certification from Hardware Supplier in duplicate to Architect as soon as possible after installation of all hardware.
 - C. **Handicapped Requirements:** Provide and install hardware in compliance with the Arizona Revised Statutes for the handicapped.

1. GENERAL REQUIREMENTS: Confirm appropriateness of all hardware and provide hardware that installs without conflict with other hardware and is compatible in size and configuration for installation in the doors and frames as detailed and specified. Supply all template information necessary for installation to the Contractor and hardware installer. Furnish hardware to match templates provided.
 - A. Supply templates to door and frame manufacturers, as required to enable proper and accurate sizing and locations of cutouts for hardware.
 - B. Items of hardware not specified but required for completion of the work shall be furnished of type and quality suitable to the service required and comparable to adjacent hardware at no additional cost to the Owner.
1. SUBMITTALS:
 - A. Product Data: Submit manufacturers' technical information for each item of hardware. Include whatever information may be necessary to show compliance with requirements, and include instructions for installation, instructions for maintenance of operating units and, finish, and other pertinent data.
 - B. Hardware Schedule: Prior to delivery of hardware, the Finish Hardware supplier shall prepare and submit complete schedules of all Finish Hardware required. Hardware sets on schedule shall be designated in the same manner as on the hardware schedule at the end of this section.
 1. Based on builders hardware indicated, organize hardware schedule into hardware sets, in a vertical format, indicating complete designations of every item required for each door opening. Include the following information:
 - Type, style, function and finish of each hardware item.
 - Name and manufacturer of each item and representative catalog cuts for each item.
 - Manufacturer's complete catalog number.
 - Fastenings and other pertinent information.
 - Location of hardware set cross-referenced to indications on drawings both on floor plans and in door and frame schedule.
 - Explanation of all abbreviations, symbols, codes, etc. contained in schedule.
 - Mounting locations for hardware.
 - Door and frame sizes and materials.
 - C. Operation and Maintenance: Provide Owner with manufacturer's parts list and maintenance instructions for each type of hardware supplied, include necessary wrenches and tools required for proper maintenance and adjustment of hardware, all as supplied with hardware when shipped to Contractor.

- D. Certification: Inspect the installation of all hardware and related items. At the completion of installation, submit certification that material is properly installed, according to manufacturer's printed instructions.
- E. Guarantee: Provide written guarantee for all hardware against defects in materials and workmanship for one year. Repair, replace, or otherwise correct deficient materials at no additional cost to the Owner.
- F. Keying Schedule: Prepared by or under the supervision of supplier, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1. DELIVERY, STORAGE AND HANDLING:

- A. Package each item of hardware and each lock separately in individual containers, complete with necessary screws, keys, instructions and installation templates for spotting mortising tools. Mark each container with heading number and number corresponding to numbers shown on Finish Hardware schedule.
- B. Inventory hardware jointly with representative of the hardware supplier and the hardware installer until each is satisfied that the count is correct.
- C. The hardware shall be fitted prior to finishing doors, as applicable, and then removed and finishing completed before final installation of hardware.
- D. The Contractor shall prepare a suitable storage space for all Finish Hardware and shall keep it under lock after it has been delivered to the building. He shall take full responsibility for all items of hardware after delivery. Install all hardware without marring or damaging hardware or other work. Replace all marred or damaged work. Adjust hardware for easy operation.

1. COORDINATION AND QUALITY OF WORKMANSHIP: Install closers, stops and other hardware as scheduled. Contractor shall coordinate for provision of extra support blocking for all interior and exterior applied hardware as needed for secure installation.

- A. All hardware shall be installed by workmen skilled in this type of work, and the installation of the hardware shall in no manner detract from the appearance of the doors. Faulty workmanship shall be cause for rejecting the doors. Where manufacturers specify certain requirements in installing doors, these requirements shall be called to the attention of the workmen, and they shall be followed.

PART 2 - MATERIALS

- 2.1 HAND OF DOOR: The drawings show the direction of swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of the door movement as shown. Notify the Architect of discrepancies.
- 2.2 BASE METALS: Produce hardware units of the basic metal and forming method indicated, using the manufacturer's standard metal alloy, composition, temper and hardness, but in no case of lesser (commercially recognized) quality than specified for the applicable hardware units by FS FF-H-10 ,

FS FG-G-111, FS FF-H-11 , and FS FF-H-121. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.

- 2.3 FASTENERS: Furnish finish hardware with all necessary screws, bolts, or other fastenings of suitable size and type to anchor the hardware in position for heavy use and long life and of compatible material and finish. Furnish fastenings with anchors according to material to which it is applied, and as recommended by the manufacturer. Fasten closers on wood or mineral core doors with sex nuts and through bolts.
- A. Manufacture hardware to conform to the published templates and prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
 - B. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (under any condition) screws to match the hardware finish, or if exposed in surfaces of other work, to match the finish of such other work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
 - C. Provide concealed fasteners for hardware units which are exposed when the door is closed, except to the extent no standard units of the type specified are available with concealed fasteners.
- 2.4 KEYING: By Owner.
2. FINISH: Provide matching finishes for hardware units at each door or opening, to the greatest extent possible, and except as otherwise indicated. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of hardware exposed at the same door or opening. In general, match items to the manufacturer's standard finish for the latch and lock set (or push-pull units if no latch-lock sets) for color and texture.
- A. Provide finishes which match those established by the BHMA.
 - B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standard, but in no case less than specified for the applicable units of hardware by referenced standards.
 - C. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in "Materials and Finishes Standard 1301" by the BHMA, including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
 - D. Typical Finishes: US2 D, and either stainless steel or painted to match, as standard with manufacturer.
2. ACCEPTABLE MANUFACTURERS:
- A. Locksets: Schlage ND series Class 1 cylindrical locksets with Rhodes trim. Provide all locksets less cylinder.

- B. Hinges Ball bearing butt hinges, heavy weight for exterior and standard weight interior. Provide 3 each 4-1/2 x 4-1/2 for doors up to 4 , with an additional hinge for taller doors. Stanley, Hager.
- C. Exit Devices: Von Duprin 99 with cylinder dogging, less cylinder, with trim as noted. Owner will provide thumbturn to operate/
- D. Closers: LCN 4040XP in 9 powder coated aluminum finish. Hold open and/or cushion stop as noted.
- F. Seals: Silicone bulb-type, self-adhering, equal Pemko S D.
- G. Weatherstripping: Low-profile jamb weatherstripping with concealed fastener and brush pile weatherstripping. Equal Pemko 29310CP.
- H. Door Shoes: Half-surface with drip and brush weatherstrip. Equal Pemko 2230CNB.
- I. Thresholds: depth saddle type, height, with reinforcing struts below. Equal Pemko 1 1, clear finish.
- K. Drip Heads: Projecting clear anodized drip, equal Pemko 34 C.
- L. Kickplates: 10 H x 2 LDW, .0 0 thickness stainless steel, with eased edges.
- M. Push/Pull Sets: Push equal Trimco 1001 .0 0 stainless steel plate, pull equal Trimco 101 with CTC cylindrical pull.
- N. Vandal Resistant Pulls: Equal Trimco Anti-Vandal Pulls, 109 RG.
- O. Electric Strikes and Power Supplies:
 - a. For Exit Devices on single doors: Surface mounted, Grade 1, 24VDC standard, fail secure, equal Von Duprin 300.
 - b. For Cylindrical Locksets: Templated, Grade 1, 12 or 24V, field selectable fail safe/fail secure. Equal Von Duprin 100.
 - c. Power Supplies: Equal Von Duprin PS902: Schlage 2 amp power supply 12/24 VDC output, field selectable accepts 1 optional distribution board.
 - d. Card readers and other access control accessories: By Owner s security vendor.
- R. Provide mortise cylinders for exit devices and deadlatches.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Mount hardware units at heights indicated in "Recommended Locations of Builders Hardware for Standard Steel Doors and Frames, by the Door and Hardware Institute, except as specifically indicated or required to comply with governing regulations, and except as may be otherwise directed.
- B. Install each item of hardware in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reapplication or reinstallation or application of surface protections with finishing work specified in the Division 9 sections. Do not install surface mounted items until finishes have been completed on the substrate.
- C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards. Set thresholds in mastic using suitable manufacturer-supplied expansion anchors.
- E. Set all thresholds solidly in grout or mastic using suitable expansion anchors

3.2 ADJUST AND CLEAN: Adjust and check each operating item of hardware and each door, to ensure the proper operation or function of each unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.

- A. 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 final acceptance 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 balancing and operation of heating and ventilating equipment. Instruct Owner's personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.3 CONTINUED MAINTENANCE SERVICES:

- A. The General Contractor shall arrange the following to ensure a complete job:
1. Approximately six months after the acceptance of the hardware in each area, the installer, accompanied by the representative of the lockset distributor, shall return to the project and readjust every item of hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation. Prepare a written report of current and predictable problems in the performance of the hardware.

PART 4 - HARDWARE SCHEDULE

General: While the following hardware sets are intended to cover all doors and establish a type and standard of quality, it shall be the specific duty and responsibility of the finish hardware supplier to examine the plans and specifications and furnish proper hardware for all openings, whether listed or not.

HARDWARE SCHEDULE: For each door or pair of doors provide the following:

SET 01

Doors 101, 101A, 102, 102A, 10 , 110, 110A, 111A, 112, 201, 201B, 202, 20 B, 208, 221, 202B, 203, 203B, 20

Hinges
Closer w/Cushion Stop
Exit NLOP
VR Pull
Weatherstrip
Door Bottom
Threshold
Electric strike for rim exit
CR by Owner s vendor

SET 02

Doors 110B

Hinges
Classroom Lockset
Kickplate
Stop

SET 03

Doors 207, 220

Hinges
Closer w/Cushion Stop
Storeroom
Weatherstrip
Door Bottom
Threshold
Electric strike
CR by Owner s vendor

SET 0

Doors 108, 109, 115

Hinges
Closer w/HO
Storeroom
Weatherstrip
Door Bottom
Threshold
Drip Head

SET 05

Doors 101B, 102B, 103, 103A, 111, 111B, 201A, 202A, 203A, 20 A, 206, 207A, 222

Hinges
Closer
Storeroom
Kickplate
Stop
Electric strike
CR by Owner s vendor

SET 06

Doors 113

Hinges
Closer
Classroom
Kickplate
Auto door bottom
Seals

SET 07
223, 22 , 22 A

Hinges
Storeroom
Surface bolts with DPS
Closer with OH/cushion stop
Astragal
Drip Head
Threshold
Door bottoms

END OF SECTION

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes glazing for the following locations, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Lights in doors and interior and exterior framing.
- B. Types of glazing materials include:
 - 1. 1 insulated clear units with low-E coating for exterior openings.
 - 2. 1 fully tempered insulated units for exterior doors.
 - 3. clear fully tempered safety glazing as needed or indicated for interior openings.
- C. Section 0 1113 Steel (HM) Doors and Frames.
- D. Section 0 141 Wood Doors.
- E. Section 0 4413 Aluminum Framing and Entrances.

1.3 DEFINITIONS

- A. Deterioration of Insulating Glass: Failure of hermetic seal under normal use due to causes other than glass breakage and improper practices for maintaining and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, condensation within the unit, or discoloration.

1.4 SUBMITTALS

- A. General: Submit product data for each glass product and glazing material indicated.
- B. Product certificates signed by glazing materials manufacturers certifying that their products comply with specification requirements.

1. SYSTEM DESCRIPTION

A. Design Requirements

1. Provide glazing systems capable of withstanding normal thermal movements, windloads and impact loads, without failure, including loss due to defective manufacture, fabrication and installation deterioration of glazing materials and other defects in construction.
2. Provide glass products in the thicknesses and strengths (annealed or heat-treated) required to meet or exceed the following criteria based on project loads and in-service conditions per ASTM E1300.
 - a. Minimum thickness of annealed or heat-treated glass products is selected, so the worst-case probability of failure does not exceed the following:
 - 1) breaks per 1000 for glass installed vertically or not over 1 degrees from the vertical plane and under wind action.
 - 2) 1 break per 1000 for glass installed 1 degrees or more from the vertical plane and under action of wind.

1. QUALITY ASSURANCE

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. FGMA Publications: "FGMA Glazing Manual."

B. Safety Glass: Products complying with ANSI Z9 .1 and testing requirements of 1 CFR Part 1201 for Category II materials.

1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.
2. Glaze openings with safety glass as required by local codes and as shown on the drawings.

C. Insulating Glass Certification Program: Provide insulating glass units permanently marked on either spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency - Insulating Glass Certification Council.

1. WARRANTY

A. General: Warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

- B. Manufacturer's Warranty on Insulating Glass: Submit written warranty signed by manufacturer agreeing to furnish replacements for those insulating glass units that deteriorate, within 10 years after substantial completion.

Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to glass manufacturer's published instructions.

PART 2 - PRODUCTS

2.1 FLOAT GLASS

- A. ASTM C 104 , Type I, thickness 1/4".

TINT: None, Clear

Safety Glazing: As needed for location see drawings. Safety glazing shall be Kind FT fully tempered.

2.2 INSULATING GLASS PRODUCTS

- A. Insulating Glass Units for Exterior Openings: Preassembled units consisting of organically sealed lights of glass separated by a dehydrated air space complying with ASTM E 4 and with other requirements indicated for a total thickness of 1. Lite surface No. 2 (inside of exterior light) shall have a low-E coating.

Clear glass, outside light with Vitro Solarban 90 on Clear Low-E No. 2

airspace

clear inside light

SHGC:	0.23
Shading Coefficient:	0.2
Summer U:	0.2
Vis. Light:	1
UV Transmission:	
Light to Solar Gain:	2.22

Temper lites as needed for safety glazing applications. Spacer shall be manufacturer's standard color. Provide a dual seal of primary and secondary sealants, manufacturer's standards.

Exterior Doors: Provide 1 fully tempered matching clear insulating units of same performance as fixed glazing.

- 2.3 GLAZING SEALANT: Comply with sealant and glass manufacturers for selection of glass sealants which suit project application and installation conditions and which are compatible with surfaces contacted. Provide color of exposed sealants is selected by Architect.
- A. 1-Part Non-Acid-Curing Silicone Glazing Sealant: ASTM C 920 Type S Grade NS Class 2 Uses NT, G, A, and, as applicable to uses indicated, O low modulus with additional capability to withstand an increase or decrease in joint width of 0 percent of joint width and a tensile strength of 4 psi or less per ASTM D 412 at 100 percent elongation after 14 days at deg. F (2 deg. C).
 - B. Cleaners, Primers and Sealers: Type recommended by manufacturer of sealants.
 - C. Blocks and Spacers: Neoprene, EPDM or silicone as required for compatibility with glazing sealants of 0 to 90 Shore A hardness for setting blocks and, for spacers and edge blocks, of hardness recommended by glass and sealant manufacturer for application indicated.
 - D. Compressible Filler Rods: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, -10 psi compression strength for 2 percent compression.

2.4 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent, nonstaining and nonmigrating in contact with nonporous surfaces, with or without spacer rod as recommended by tape and glass manufacturers for application indicated, packaged on rolls with a release paper backing, and complying with AAMA 00.
2. FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS: Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, 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

- 3.1 PREPARATION: Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.
- 3.2 GLAZING, GENERAL
- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications. All openings shall be glazed air- and watertight using the most appropriate method.
 - 1. Comply with aluminum manufacturer's recommendations and use standard elastomeric extrusions for glazing aluminum framing.

- B. Glazing channel dimensions as indicated on Drawings provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- C. Protect glass from edge damage during handling and installation.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
- E. Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass sizes larger than 0 united inches (length plus height) as follows:
 - 1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.
 - 2. Provide 1/ -inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics. Set low-E units with correct side to exterior as indicated on each unit.
- J. 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.
- K. 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.

3.3 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 centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.4 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. PROTECTION AND CLEANING

- A. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.
- B. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents and vandalism, during construction period.
- C. Clean glass on both faces in each area of Project prior to date scheduled for inspections that establish date of Substantial Completion. Clean glass as recommended by glass manufacturer.

END OF SECTION 0 000

SECTION 092 00 PORTLAND CEMENT PLASTER (STUCCO)

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Portland cement plaster (stucco) with factory-colored acrylic finish for soffits at entries as shown on the Drawings and as specified.

1.02 RELATED WORK:

Section 0 1000 Rough Carpentry for sheathing.

Section 0 2 00 - Air Barrier (Building Wrap).

1.03 SUBMITTALS:

- A. Product Data: Submit manufacturers' product data, technical information and installation instructions.
- B. Curing Methods: Provide information on plaster curing methods after application. Note fog spray requirement and describe processes.
- B. Field Samples: Make 1 in-place sample at a typical soffit for specified acrylic finish and color (to be selected from manufacturer s standard color line). Acceptable sample may remain as part of the work.

1.04 QUALITY ASSURANCE

- A. Comply with applicable requirements of finish coat manufacturer, and the Western Lath/Plaster, Drywall Industries Association, Inc, "Reference Specifications and Data Guide", except where more stringent requirements are specified or required by local building codes.
- B. Field Samples: Make 2 samples, each feet square at locations directed by Architect, for each specified acrylic finish and color (to be selected from manufacturer s full color line). Acceptable samples may remain as part of the work.

1.0 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply plaster when substrate or ambient air temperature is less than 40 degrees F. nor more than 0 degrees F.
- B. Maintain minimum ambient temperature of 40 degrees F. for a minimum of 24 hours thereafter, or until dry. Temporary heating shall be supplied, if necessary, to maintain these conditions.
- C. During hot weather protect stucco from uneven and excessive evaporation.

PART 2 PRODUCTS

2.01 PLASTER MATERIALS

- A. Water: Clean and free of deleterious matter.
- B. Portland Cement: Conform to ASTM C150, Type I or II.
- C. Hydrated Lime: Conform to ASTM C207, Type S.
- D. Aggregate shall be clean, well graded sand or screenings from crushed stone or slag, and shall conform to ASTM C33 for fine aggregate except that it shall be graded within the following limitations:
 - 1. Passing No. 4 sieve: 100 percent
 - 2. Passing No. 10 sieve: 90 percent
 - 3. Passing No. 20 sieve: 0 percent-90 percent
 - 4. Passing No. 30 sieve: 3 percent- 0 percent
 - 5. Passing No. 40 sieve: 10 percent-30 percent
 - 6. Passing No. 100 sieve: 5 percent

2.02 FURRING AND LATHING

- A. Metal Lath: 3.4 lb./sq.yd. expanded metal, self-furring type galvanized finish.
- B. Air Barrier: See Section 05200 Air Barrier (Building Wrap).
- C. Corner Mesh: Formed steel, minimum 2 gage expanded flanges shaped to permit complete embedding in plaster minimum 2 inches wide galvanized finish.
- E. Corner Beads: Formed steel, minimum 2 gage bullnosed edge, of longest possible length sized and profiled to suit application galvanized finish.
- F. Base Screeds: Formed steel, minimum 2 gage square edge, of longest possible length sized and profiled to suit application galvanized finish.
- G. Casing Bead: Formed steel minimum 2 gage thickness governed by plaster thickness maximum possible lengths expanded metal flanges, with bullnosed edges galvanized finish.
- H. Control Joint Accessory: Formed steel minimum 2 gage galvanized finish accordion profile, 2 inch expanded metal flanges each side galvanized finish.
- I. Expansion Joint Accessory: Formed steel, 2 gage accordion profile, 2 inch expanded metal flanges each side galvanized finish.
- J. Tie wire shall be double annealed and galvanized conforming to Type I FS QQ-W-41, of gages specified.
- K. Anchorages: Nails, staples, or other approved metal supports, of type and size to suit application, galvanized to rigidly secure lath and associated metal accessories in place.

2.03 PROPORTIONING AND MIXING

- A. Accurately measure ingredients. Proportion successive batches exactly alike. Mix aggregate, cement and other dry materials until the mass is uniform in color and homogeneous before adding water. Determine the quantity of water necessary for the desired consistency by trial, and thereafter measure in proper proportions. Retempering will not be allowed.
- B. Mortar for coats shall consist of one volume of Portland cement to not less than three or more than five volumes of damp, loose aggregate.
- C. Hydrated lime, hydrated lime putty, or slaked lime putty may be added as a plasticizing agent, but the amount used shall not exceed 10 percent by weight nor more than 2 percent by volume of the cement used.
- D. Mix materials dry, to uniform color and consistency, before adding water.

2.04 MANUFACTURED FINISH COAT

- A. Finish: StucCoat DS444 Acrylic Finish, integrally colored, as manufactured by Dryvit, or equal by STO, Parex, or another manufacturer.

Texture: Fine sand or manufacturer equal.
Color: As selected.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces and supports to receive Work and report detrimental conditions in writing, with a copy to Architect. Commencement of Work will be construed as acceptance of subsurfaces. Verify, before proceeding with this Work that required inspections of existing conditions have been completed.
- B. Coordination with other Work: Coordinate with other work which affects, connects with, or will be concealed by this Work.

3.02 LATH AND TRIM INSTALLATION

- A. Moisture Barrier: Ensure that air/moisture barrier wrap has been installed per manufacturer s guidelines.
- B. Install lath with the long dimensions of the sheet across supports and attach to the studs or furring using 1 gage tie wire, or by nailing or by equivalent attachment spaced at intervals not exceeding inches along such studs or furring members. Make end laps of lath only over supports and stagger endlaps in adjacent courses.

- C. Metal Trim: Where stucco terminated against dissimilar materials, install casing beads. Securely fasten trim members to maintain their position in accordance with recommended practice.

3.03 STUCCO APPLICATION

- A. Apply scratch coat with sufficient pressure so that it is forced through the metal reinforcement and against the backing to form full keys and to embed reinforcement completely. Apply to an approximate thickness of 3/4 inch from the face of the backing. Scratch to provide bond for succeeding coat.
- B. Apply brown coat not sooner than 4 hours after the application of the scratch coat. Dampen scratch coat evenly to obtain uniform suction. Apply to an approximate thickness of 3/4 inch. Bring surface to a true, even surface by floating or rodding and leave rough, ready to receive finish coat.
- C. Apply finish coat not sooner than seven days after the application of the preceding coat. Before applying, dampen the surface of the preceding coat evenly to obtain uniform suction. Thickness of the finish coat shall be sufficient to secure the texture specified but in no case less than 1/4 inch and the total thickness of the stucco shall be at least 1 1/4 inch from the face of the backing. Avoid excessive troweling.
- D. When applying the finish, plan work so entire wall can be completed at one time to eliminate joining marks.
- E. For machine application to masonry or other solid surfaces, apply a first coat with sufficient pressure to ensure tight contact with complete coverage of solid base surface. Bring surface to a true and even plane and float to a uniformly rough surface to provide bond for finish coat. Machine apply and broom dash by hand the finish coat to match accepted sample.
- G. Temperature shall be 40 degrees F. and rising during application and for 4 hours thereafter.
- H. Curing: Keep each coat of stucco damp for at least 4 hours after application moistening of each coat shall begin as soon as the stucco has hardened sufficiently so as not to be injured. Apply water in a fine fog spray. Avoid soaking the wall. Apply only as much water as can be readily absorbed.

3.04 REPAIRS

- A. Remove and replace stucco which has cracks, blisters, pitting, discoloration or other defects.
- B. Repairing of defects will be permitted only when approved by the Architect.
- C. Repairs shall match existing work.

3.0 FIELD QUALITY CONTROL

- A. Coordination: In Work under this Section, coordinate with other Trades whose work connects with, is affected or concealed by cement stucco. Before proceeding, make certain required inspections have been made.

3.0 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises.

END OF SECTION

SECTION 092900 - GYPSUM DRYWALL SYSTEMS

PART 1 - GENERAL

- A. RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
1. Section 0 4000 Cold-Formed Steel Framing.
- B. DESCRIPTION OF WORK:
1. Types of work include:
 - Gypsum drywall including screw-type metal support system for perimeter wall furring and interior partitions. Sound attenuation blankets for partitions as shown.
 - Drywall finishing, including trim, priming before texturing, and texturing.
 2. Painting of drywall is specified in Section 099000. Primer on top of texture is specified in that section.
- C. QUALITY ASSURANCE:
1. Gypsum Board Standard: Comply with applicable requirements of ANSI/ASTM C 40 for application and finishing of gypsum board, unless otherwise indicated.
 2. Steel Framing Standard: Comply with applicable requirements of ASTM C 4 for installation of steel framing for gypsum board.
 3. Using Gypsum Board for Walls and Ceilings: Comply with requirements of GA-201.
 4. Gypsum Board Terminology Standard: GA- 0 by Gypsum Association.
 - . Gypsum Construction Handbook: Proprietary publication of United States Gypsum.
- D. SUBMITTALS:
1. Product Data: Submit manufacturer's product specifications and installation instructions for each gypsum drywall component.
 2. Samples: Submit 3 - 1' x 2' samples of drywall of specified texture in varying density for Owner and Architect's approval.

E. DELIVERY, STORAGE AND HANDLING:

1. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.
2. Store materials inside under cover and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, corrosion and damage from construction traffic and other causes. Neatly stack gypsum boards flat and support to prevent sagging.
3. Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect metal corner beads and trim from being bent or damaged.

F. PROJECT CONDITIONS:

1. Environmental Requirements, General: Comply with requirements of referenced gypsum board application standards and recommendations of gypsum board manufacturer, for environmental conditions before, during and after application of gypsum board.
2. Cold Weather Protection: When ambient outdoor temperatures are below deg F maintain continuous, uniform, comfortable building working temperatures of not less than deg F for a minimum period of 4 hours prior to, during and following application of gypsum board and joint treatment materials or bonding of adhesives.
3. Ventilation: Ventilate building spaces as required to remove water in excess of that required for drying of joint treatment material immediately after its application. Avoid drafts during dry, hot weather to prevent too rapid drying.

PART 2 - PRODUCTS

A. METAL SUPPORT MATERIALS:

1. Ceiling Support Materials and Systems:
 - a) General: Size ceiling support components to comply with ASTM C 4 unless otherwise indicated.
 - b) Main Runners: Steel channels with rust inhibitive paint finish, hot or cold-rolled.
 - c) Hanger Wire: ASTM A 41, soft, Class 1 galvanized, ga.
 - d) Metal Studs for Ceilings and Soffits: 20 ga (22 mil), depth as indicated.
 - e) Hanger Anchorage Devices: Screws, clips, bolts, or other devices applicable to the indicated method of structural anchorage for ceiling hangers and whose suitability for use intended has been proven through standard construction practices or by certified test data. Size devices for 3x calculated load supported.

2. Wall/Partition Support Materials:

- a) Studs: ASTM C 4 . Manufacturers are encouraged to use post-industrial or post-consumer recycled materials in the fabrication of metal framing members submit statement as specified above.

Depth of Section: 3-1/2 ", " or as otherwise indicated.

Thickness:
20 ga. equivalent (19 mil)

- b) Runners: Match studs type recommended by stud manufacturer for floor and ceiling support of studs, and for vertical abutment of drywall work at other work.
- c) Partition Bridging: Prefabricated steel channels or clips which fit into slots in drywall studs.
- d) Hat Channels: Metal furring channels, / depth, 2 ga. corrosion-resistant steel.

3. PARTITION MATERIALS:

- a) GYPSUM WALLBOARD: ASTM C 3 , of types, edge configuration and thickness indicated below in maximum lengths available to minimize end-to-end butt joints.

Type: Type X.
Thickness: / " typically

- b) CEILINGS: Standard Type X / gypsum panels.

4. TRIM ACCESSORIES: Provide manufacturer's standard trim accessories, formed of galvanized steel (no plastic), with either knurled and perforated or expanded flanges for nailing or stapling, and beaded for concealment of flanges in joint compound. Provide corner beads, J-trim, L-type edge trim-beads, U-type edge trim-beads, special L-kerf-type edge trim-beads, and one-piece control joint beads.

JOINT TREATMENT MATERIALS:

- a) General: ASTM C 4 type recommended by the manufacturer for the application indicated, except as otherwise indicated.
- b) Joint Tape for Drywall: Perforated paper type.
- c) Joint Compound: Provide chemical-hardening-type for bedding and filling, ready-mixed vinyl-type or vinyl-type powder type for topping, meeting ASTM C 4 . Provide type suitable for use at moisture resistant partitions, as required.
- d) Texturing Compound for walls, soffits, and ceilings: A ready-mixed joint compound/topping compound or USG Ready-Mixed Texture Finish, or equal by Hamilton.

Texture: Light hock and trowel.

- e) Surface Primer: Latex primer for preparation of drywall surface prior to application of texture as acceptable to drywall and texture material manufacturer, low V.O.C. (Separate from primer applied prior to painting.)

MISCELLANEOUS MATERIALS: Sealants and adhesives shall have a VOC content of 20 g/L or less when calculated according to 40 CFR 9, Subpart D (EPA Method 23).

- a) General: Provide auxiliary materials for gypsum drywall work of the type and grade recommended by the manufacturer of the gypsum board.
- b) Gypsum Board Screws: Comply with ASTM C 4 . Provide recommended corrosion resistant type for fastening moisture resistant and cement board.
- c) Adhesive: Construction adhesive, complying with ASTM C , VOC-compliant.
- d) Sound Attenuation/Insulation Batts: Mineral wool lightweight sound attenuating batts. Equal of Johns Manville Sound Attenuation Fire Batt (SAFB), 3-1/2 , or thickness as indicated.

ACOUSTICAL SEALANT

- a) Acoustical sealant shall be non-skinning, non-hardening, flexible sealant specifically designed for sealing gypsum wallboard. Sealant shall be capable of spanning 1/2-inch wide by 3/4 -inch deep gaps. Synthetic rubber based products comply with ASTM Standard D-21 and acrylic latex based products comply with ASTM Standard C- 34 and shall be VOC-compliant.

Acceptable Products: Tremco (00-321- 90), USG acoustical sealant, Pecora AC-20 FTR (00- 23-), or approved equivalent.

PART 3 - EXECUTION

A. PREPARATION FOR METAL SUPPORT SYSTEMS:

1. Ceiling Anchorages: Coordinate work with structural ceiling work to ensure that structural anchorage provisions have been installed to receive ceiling hangers.
2. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement as follows:
 - a. Where partition and wall framing abuts overhead structure or structural walls:
 - 1) Provide slip or cushioned type joints to attain lateral support and avoid axial loading.

- b. See drawings for related requirements.

B. INSTALLATION OF METAL SUPPORT SYSTEMS:

1. General: Metal Support Installation Standard: Comply with ASTM C 4.
 - a. Ceiling Support Suspension Systems: Secure hangers to structural support by connecting directly to structure where possible, otherwise connect to studs, clips, rods, channels, or other anchorage devices or fasteners as required or indicated.
 - b. Space main runners 4'-0" o.c. and space hangers 4'-0" o.c. along runners, except as otherwise shown.
 - c. Level main runners to a tolerance of 1/4" in 12'-0", measured both lengthwise on each runner and transversely between parallel runners.
 - d. Wire-tie or clip furring members to main runners and to other structural supports as indicated.
 - e. Space furring members as indicated or recommended in handbook.
 - f. Stud Ceilings/Soffits: Attach runners to ceilings and sidewalls, spaced as indicated, placing fasteners close to outside flange of runner. On stud walls, space fasteners to engage studs. Provide bracing members in accordance with handbook. Fasten at intervals and using fasteners in accordance with Gypsum Construction Handbook and drawings for a braced soffit.
 - g. Install auxiliary framing or blocking at termination of drywall work, and at openings for light fixtures and similar work, as required for support of both the drywall construction and other work indicated for support thereon.
- 2) Wall/Partition Support Systems:
 - a) Install supplementary framing, blocking and bracing at terminations in the work and for support of fixtures and casework, equipment, services, wall-mounted door stops, heavy trim, grab bars, toilet accessories, furnishings and similar work to comply with details indicated or if not otherwise indicated, to comply with applicable published recommendations of gypsum board manufacturer, or if not available, of "Gypsum Construction Handbook".
 - b) Install runner tracks at floors, ceilings and structural walls and columns where gypsum drywall stud system abuts other work, except as otherwise indicated.
 - c) Extend partition stud system as indicated to the structural support and substrate above the ceiling except where partitions are indicated to terminate at suspended ceilings. Cut studs 3/4" short of full height. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

- 1) For fire-resistive-rated partitions requiring partitions to extend to the underside of floor/roof decks or other continuous solid structural surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed, to support gypsum board closures needed to make partitions continuous from floor to underside of solid structure.
- d) Stud Spacing: Space studs 1 " o.c., unless otherwise indicated.
- e) Bridging: Provide continuous channel bridging at mid-height of typical partitions, and at third points in full-height partitions friction fit or connect at each stud.
- f) Frame door openings with double 20 ga. studs to comply with details indicated or if not otherwise indicated, to comply with "Gypsum Construction Handbook". Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames install runner track section (for jack studs) at head and secure to jamb studs.
 - 1) Provide 3 studs at all corners.
- g) Extend vertical jamb studs through suspended ceilings and attach to underside of floor or roof structure above, unless otherwise indicated.
- h) Frame openings other than door openings in same manner as required for door openings and install framing below sills of openings to match framing required above door heads.
- i) Install sound batts in framing at indicated locations. Fit between framing members and trim neatly around penetrations and obstructions. Fill gaps with insulation.

C. GENERAL GYPSUM BOARD INSTALLATION REQUIREMENTS:

1. Gypsum Board Application and Finishing Standards: ASTM C 40 and GA 21 .
2. Install wall boards to minimize joints requiring treatment, as well as to minimize end butt joints. Locate exposed end-butt joints as far from center of walls and ceilings as possible.

In multi-layer applications either screw or laminate the 2nd layer to the first. Stagger joints in second layer so they don t overlap with those in the first.
3. Install ceiling boards in the direction and manner which will minimize the number of end-butt joints, and which will avoid end joints in the central area of each ceiling. Stagger end joints at least 1'-0".
4. Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16 " open space between boards. Do not force into place.

- . Locate either edge or end joints over supports, except in horizontal applications or where intermediate supports or gypsum board back-blocking is provided behind end joints. Position boards so that like edges abut, tapered edges against tapered edges and mill-cut or field-cut ends against mill-cut or field cut ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.
 - . Attach gypsum board to supplementary framing and blocking provided for additional support at openings and cutouts.
 - . Form control joints and expansion joints with space between edges of boards, prepared to receive trim accessories.
 - . Cover both faces of steel stud partition framing with gypsum board in concealed spaces (above ceilings, etc.), except in chase walls which are braced internally.
9. Except where concealed application is required for sound, fire, air or smoke ratings, coverage may be accomplished with scraps of not less than sq. ft. area, and may be limited to not less than of full coverage. Cut and fit gypsum board around pipes, ducts, conduits, and structural members projecting below underside of floor/roof decks.
 10. Isolate perimeter of non-load-bearing drywall partitions at structural abutments. Provide 1/4" space and trim edge with U bead edge trim. Seal joints with acoustical sealant.
 11. Space fasteners in gypsum boards in accordance with referenced standards and manufacturer's recommendations, except as otherwise indicated.
 12. **ACOUSTICAL SEALANT USAGE** Sound Attenuating Construction: Where partitions are indicated to receive sound insulation, coordinate for installation of acoustical batts. Seal the work at perimeters, control and expansion joints, openings and penetrations with a continuous bead of acoustical sealant. Comply with acoustical construction details, and manufacturer's recommendations for location of beads, and close off sound-flanking paths around or through the work, including sealing of partitions above acoustical ceilings and the sealing of all penetrations through partitions.
 - 1) Use acoustical sealant to form an airtight seal at all penetrations and perimeter of sound-rated partitions, floors and ceilings. Comply with ASTM C919. Use backer-rod where gaps to be sealed exceed 3/4 -inch.
 - 2) Apply acoustical sealant as a continuous bead along gypsum board face layer at all head and sill conditions of sound-rated partitions and around the perimeter of resilient ceilings.
 - 3) Apply expanding foam sealant where multiple pipes or conduits penetrate sound-rated construction.

D. GYPSUM DRYWALL APPLICATION:

- 1) Ceilings: Apply ceiling boards prior to installation of wall boards if at all possible.

- 2) Fastening Methods: Apply single layer gypsum boards to supports with screws spaced in accordance with ASTM C 4-2004.

E. INSTALLATION OF DRYWALL TRIM ACCESSORIES:

- 1) General: Apply trim as shown and as specified herein. Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges by nailing or stapling in accordance with manufacturer's instructions and recommendations.
- 2) Install metal corner beads at external corners of drywall work.
- 3) Install metal edge trim whenever edge of gypsum board would be exposed or semi-exposed. Provide type with face flange to receive joint compound. Install L-type trim where work is tightly abutted to other work, and install special kerf-type where other work is kerfed to receive long leg of L-type trim. Install U-type trim where edge is exposed, revealed, gasketed, or sealant-filled (including expansion joints).
- 4) Install control joints as follows:

Partition - interior	max. 30' o.c.
Ceiling - interior	
with perimeter relief	max. 0' o.c.
without perimeter relief	max. 30' o.c.

Installation of control joints will be reviewed and if quantity or placement is not according to specification, work shall be removed and replaced as directed.

F. FINISHING OF DRYWALL:

- 1) General: Apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fastener heads, surface defects and elsewhere as required to prepare work for final finish. Prefill open joints and rounded or beveled edges as recommended by manufacturer.
- 2) Apply joint tape at joints between gypsum boards, except where trim accessories are indicated.
- 3) Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.
 - a. Level 1 for ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistive-rated assemblies and sound-rated assemblies.
 - b. Level 4 for all remaining gypsum board surfaces unless otherwise indicated.
 - 1) For level 4 gypsum board finish, embed tape in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads, and

accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects ready for decoration.

- d. Seal and treat joints in tile backing board by embedding joint tape in same mortar as being used for setting tile.

G. APPLICATION OF PRIMER AND TEXTURE FINISH:

- 1) Primer Application: Mix in accordance with manufacturer's instructions. Apply a full coverage coat with roller or preferably spray gun. Allow to dry before proceeding with texturing application.
- 2) Finish Application: Mix and apply texture finish to drywall wall, soffits, and ceilings, and other surfaces indicated to receive finish in strict accordance with manufacturer's instructions to produce a uniform texture without starved spots or other evidence of thin application, and free of application patterns. Final texture application shall be match that selected by Architect from submitted texture samples.
- 3) Remove any texture droppings or overspray from door frames, windows and other adjoining work.

H. PROTECTION OF WORK:

- 1) Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures gypsum drywall work being without damage or deterioration at time of substantial completion.

END OF SECTION 092900

SECTION ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes acoustical panel ceilings as follows:
 - 1) 2 x 4 panels, mineral fiber, suspended
 - 2) 1 /1 wide steel suspension grid.

1.3 RELATED WORK:

- A. Drywall ceilings are specified in Section 092900.

1.4 SUBMITTALS: Submit product data for each type of product specified. Submit samples of each type of panel. Submit color samples for clouds.

1. COORDINATION OF WORK: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition system.

1. DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1. EXTRA MATERIALS

- A. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with appropriate labels.

- 1. Lay-in Acoustical Ceiling Units: Furnish 2 boxes of ceiling panels installed.

1. QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 2. Identify materials with appropriate markings of applicable testing and inspecting agency.
2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 124 for Class A materials as determined by testing identical products per ASTM E 124:

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Mineral Base Panels, fine smooth non-directional finish high noise reduction coefficient, butt edge, 3/4" thick.

1. Minimum Performance Values

NRC . 0

CAC 3

Light reflectance: Minimum 0. .

VOC Formaldehyde No added

Moisture Resistance HumiGuard Plus and Antimicrobial

a. 24" x 4 "

1) Armstrong Cirrus

2) Equal by USG, Certaineed

USE: Typical

2. Specialty Areas as needed for cleanability, such as support spaces: Vinyl Faced Gypsum Board Panel Ceilings: White vinyl overlay, thickness, 2 x 4 size, square edges, suspended in 1 /1 face steel grid, painted white.

Pattern: USG vinyl-faced gypsum board panels

2.2 METAL SUSPENSION SYSTEMS, GENERAL

- A. Standard for Metal Suspension System: Provide 1 /1 " wide metal suspension for 2 x4 panels that complies with applicable ASTM C 3 requirements.
- B. Finish and Color: Provide manufacturer's factory-applied paint finish white.
- C. Attachment Devices: Size for times design load indicated in ASTM C 3 , Table 1, Direct Hung unless otherwise indicated.
- D. Edge Moldings and Trim
1. Angle (L) moldings for all areas.

2.3 DIRECT-HUNG SUSPENSION SYSTEMS

- A. Standard-Face Double-Web Steel Capped Suspension System: Main and cross-runners roll-formed from prepainted or electrolytic zinc-coated cold-rolled steel sheet 1 /1 wide face Heavy-Duty System Cap: steel, painted white.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine structure to which ceiling systems attach to make sure all is ready to receive suspension systems. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.
- B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders.
- C. Coordinate for above ceiling work that could damage installed panels.

3.3 INSTALLATION

- A. General: Install acoustical ceiling systems to comply with installation standard referenced below, per manufacturer's instructions and CISCA "Ceiling Systems Handbook."
 - 1. Standards for Installation of Ceiling Suspension Systems: Comply with ASTM C 3 and ASTM E 0.
- B. Suspend ceiling hangers directly or indirectly from building structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 - 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 4. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices that are secure and appropriate for structure to which hangers are attached as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

- . Space hangers not more than 4'-0" o.c. along each member supported directly from hangers, unless otherwise shown, and provide hangers not more than 1/2 inches from ends of each member.
 - . Connect wires or other supports to structure.
- C. Install edge moldings at perimeters of acoustical ceiling areas, at terminations (such as building columns), and where necessary to conceal edges of acoustical units.
- 1. Screw-attach moldings to substrate at intervals not over 12 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to tolerance of 1/8 inch in 12'-0". Miter corners accurately and connect securely.
- D. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.
- 1. Handle all panels carefully to avoid chipping edges. Take care with clouds to not damage painted finish.
 - 2. Coordinate with other forces who may be performing work at the site (such as pulling cable) to protect panels from damage.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove chipped or dented panels and replace at completion of work.

END OF SECTION 09 133

SECTION 096500 LUXURY VINYL TILE AND RESILIENT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Resilient wall base, transition and reducer strips.
 - 2. Luxury vinyl tile with factory-applied finish.

1.3 SUBMITTALS

- A. Submit product data for each type of product specified.
- B. Submit full range of samples for verification purposes of flooring, rubber base, and termination accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver flooring and accessories to site in original manufacturer's unopened packages and containers each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.
- B. Store flooring materials in dry spaces protected from the weather with ambient temperatures maintained between 0 deg F and 90 deg F.

1. PROJECT CONDITIONS

- A. Maintain a minimum temperature of 0 deg F in spaces to receive flooring for at least 4 hours prior to installation, during installation, and for not less than 4 hours after installation. After this period, maintain a temperature of not less than 0 deg F.
- B. Close spaces to traffic during installation.

- 1. SEQUENCING AND SCHEDULING: Install flooring and accessories after other finishing operations, including painting, have been completed.

- 1. EXTRA MATERIALS: Deliver extra materials to Owner. Furnish extra materials matching products installed, packaged with protective covering for storage and identified with labels clearly describing contents. Furnish two boxes of LVT provided and one box of rubber base.

PART 2 PRODUCTS

- 2.1 RUBBER WALL BASE: FS SS-W-40, Type I 4" high 1/2" gage 100 extruded virgin synthetic rubber with matching end stops standard toe cove. Roppe Pinnacle, or equal by Johnsonite, Mannington.
- 2.2 LUXURY VINYL TILE: Type 1, Grade 1, Type B (embossed). This type of tile requires no post-applied wax or acrylic sealer. Factory-applied coating requires only damp mopping and periodic buffing.
- a. Wearing Surface: Slight texture with micro-beveled edges
 - b. Overall Thickness: .09 inch
 - c. Wear Layer Thickness: 0.20 inch with equal to Quantum Guard Elite polyurethane coating.
 - d. Size: As scheduled
 - e. Static Load ASTM F904 Passes 2,000 psi residual indentation: .00 in.
 - f. Pattern: See Materials and Finish List.
 - g. Fire-Test-Response Characteristics:
 - 1) Critical Radiant Flux Classification: Class I, not less than 0.4 W/sq. cm per ASTM E 413.
- 2.3 TRANSITION AND EDGE STRIPS: As detailed or needed by the work, rubber, 1/2" gage color as selected by Architect. Transitions may include concrete/LVT.
- 2.4 INSTALLATION ACCESSORIES
- A. Concrete Slab Primer: Nonstaining type as recommended by flooring manufacturer.
 - B. Patching/leveling compounds: Cementitious high-strength underlayment, trowelable and quick-setting. Equal of ARDEX SD-F or K-100, as appropriate for work.
 - C. Adhesives (Cements): Water-based, water-resistant, low-V.O.C. type, only as recommended by each flooring and rubber base manufacturer, respectively, for installation of their products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 10 and the following:
 - 1. Concrete Moisture Test: Perform moisture tests on concrete floors regardless of the age or grade level with a minimum of three tests for the first 1000 square feet. The test shall be a calcium chloride test. One test shall be conducted for every 1000 sq. ft. of flooring. The test shall be conducted around the perimeter of the room, at columns and where moisture may be evident.

For the most accurate results, the weight of the calcium chloride dish shall be made on the job site at the start and end of each test. A diagram of the area showing the location and results of each test shall be submitted to the architect, general contractor or end user. If the test results exceed the limitations, the installation shall not proceed until the problem has been corrected.

2. Concrete pH Test: Perform pH tests on concrete regardless of the age or grade level. If the pH is greater than 9, it must be neutralized prior to beginning the installation to a minimum of .
3. Substrates shall be dry and free of materials which would interfere with bonding of adhesive, such as mastic or carpet glue and subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
4. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with manufacturer's installation specifications to prepare substrates indicated to receive floor covering materials.
 1. Use trowelable cementitious-based leveling and patching compounds per floor covering manufacturer's direction to fill cracks, holes, and depressions in substrates.
 2. Broom or vacuum clean substrates to be covered by floor covering immediately before installation. Following cleaning, examine substrates to determine if there is visually any evidence of moisture, alkaline salts, carbonation, or dust. Solvent procedures may be used to remove old adhesive residues or similar materials from existing floors, but do not grind or use other mechanical means that cause dusting of the surface or distribution of surface dust into the air.
 3. Apply concrete slab primer, if recommended by flooring manufacturer, prior to application of adhesive. Apply according to manufacturer's directions.

3.3 INSTALLATION

- A. General: Strictly comply with tile or sheet flooring manufacturer's installation instructions.
 1. Lay out tile flooring to comply with the following requirements:
 - a. Maintain uniformity of floor covering direction.
 - a. Arrange for a minimum number of seams and place them in inconspicuous and low traffic areas, but in no case less than inches away from parallel joints in flooring substrates.
 - b. Match edges of floor coverings for color shading and pattern at seams.
 2. Scribe, cut, and fit tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture, including cabinets, pipes, outlets, edgings, and thresholds.
 3. Extend into toe spaces, door reveals, closets, and similar openings.
 4. Maintain reference markers, holes or openings that are in place or plainly marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other nonpermanent marking device.

- . Adhere floor covering to flooring substrates by method approved by floor covering manufacturer.
 - a. Produce completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.
 - b. Comply with floor covering manufacturer's directions including those for trowel notching, adhesive mixing, and adhesive open and working times.
- . Hand roll floor covering in both directions from center out to embed floor covering in adhesive and eliminate trapped air. At walls, door casings, and other locations where access by roller is impractical, press floor coverings firmly in place with flat-bladed instrument.
- . Install transition trips at edges of flooring which would otherwise be exposed or at changes of flooring materials.

3.4 CLEANING AND PROTECTION

- A. Immediately after completing flooring installation:
 - 1. Remove visible adhesive and other surface blemishes using cleaner recommended by tile manufacturers.
 - a. Sweep or vacuum floor thoroughly.
 - b. Do not wash floor until after time period recommended by manufacturer.
 - c. Damp-mop flooring to remove black marks and soil.
 - d. Do NOT apply wax or acrylic sealer.
- 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 methods recommended by flooring manufacturer.
- C. Wet wipe rubber base to remove dust and marks.
- D. Clean prior to dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project.

END OF SECTION 09 00

SECTION 099000 - PAINTING

PART 1 - GENERAL

- 1.1 DESCRIPTION OF WORK: All interior and exterior work, except as noted.
- A. Work also includes:
 - 1) Painting drywall partitions and ceilings, interior and exterior hollow metal doors and frames, miscellaneous trim.
 - B. Gypsum drywall is specified in Section 092900.
- 1.2 Particular paint colors and their areas of use are indicated on the drawings in the Finish Schedule. Types of paint and coating finishes for various substrates are specified in this section.
- 1.3 "Paint" as used herein means all coating systems materials including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- 1.4 Paint exposed surfaces whether or not colors are designated in "schedules", except where natural finish of material is specifically noted as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint same as adjacent similar materials or areas.
1. Paint mechanical, electrical, or plumbing equipment that is exposed to public view. If equipment is in a mechanical/electrical room or on the roof, painting is not required.
1. Following categories of work are not included as part of field-applied finish work, or are included in other sections of these specifications.
- A. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under various sections for structural steel, miscellaneous metal, hollow metal work, and similar items.
 - B. Pre-Finished Items: Unless otherwise indicated, do not include painting when factory-finishing or installer finishing is specified for such typical items as (but not limited to) wood doors, casework, and light fixtures.
 - C. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces and duct shafts.
 - D. Finished Metal Surfaces: Metal surfaces of stainless steel, anodized aluminum, galvanized, those with factory applied finish, and similar finished materials will not require finish painting, unless otherwise indicated.

- E. Operating Parts and Labels: Moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts will not require finish painting, unless otherwise indicated.
- F. Do not paint over any code-required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

1. SUBMITTALS:

- A. Product Data: Submit manufacturer's technical information including paint label analysis and application instructions for each material proposed for use. Provide certification of VOC content for each type of coating material.
- B. Submit a list of specific paint items (type, manufacturer, formulation, and catalog number) for the Architect's review.
- C. The Contractor shall submit 2 - 1/2 x 11 samples of each paint finish in the specified sheens. Identify samples with color name and number and location on the job.

1. DELIVERY AND STORAGE:

- A. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
 - Name or title of material.
 - Manufacturer's stock number and date of manufacture.
 - Manufacturer's name.
 - Chemical composition.
 - Supplier's name and address.
 - Color name and number.
 - Application instructions.
 - Material Safety Data Sheets.
- B. Maintenance Stock: Contractor shall supply, new and unopened, 2 gallons of each type and color of each finish used on the project as maintenance stock for Owner. Label as indicated above and deliver for Owner's storage.

1.9 JOB CONDITIONS:

- A. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 0 degrees F. and 90 degrees F., unless otherwise permitted by paint manufacturer's printed instructions.
- B. Do not apply paint in rain, or when relative humidity exceeds _____ or to damp or wet surfaces unless otherwise permitted by paint manufacturer's printed instructions.

- C. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 COLORS AND FINISHES:

- A. Colors are indicated on the color schedule and are typically non-stock tints, specified by a manufacturer's color numbers. The particular manufacturer who supplies paint for project shall match these colors, subject to approval of Architect.
- B. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.
- C. Paint Coordination: Provide finish coats which are compatible with prime paints used. Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information on characteristics of finish materials proposed for use, to ensure compatible prime coats are used. Provide barrier coats over incompatible primers/finishes or remove and reprime as required. Notify Architect in writing of any anticipated problems using specified coating systems with substrates primed by others.

2.2 MATERIAL QUALITY: Products have been selected around the Dunn Edwards product line as that is the West Campus stocking manufacturer.

2.3 EXTERIOR PAINT SCHEDULE:

Hollow Metal Doors/Frames

1 coat Bloc-Rust Premium
2 coats Spartashield 100 Acrylic Semi-Gloss

2.4 INTERIOR PAINT SCHEDULE

- A. Gypsum Drywall:
Prep S-W or 12

1 coat Vinylastic Premium acrylic sealer
2 coats Spartawall Low Sheen latex
Use: Typical interior

- B. Steel Frames, Metal Fabrications:

1 coat Ultra Grip acrylic Primer (not required on previously primed surfaces)
2 coats Versaglo Semi-Gloss acrylic latex

C. Epoxy Paint as noted on finish schedule

1 coat Vinylastic Premium acrylic sealer
2 coats Enduracat

PART 3 - EXECUTION

3.1 INSPECTION

- A. Applicator must examine areas and conditions under which painting work is to be applied and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Applicator.
 - 1) Starting of painting work will be construed as Applicator's acceptance of surfaces and conditions within any particular area.
 - 2) Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, loose materials, or other conditions detrimental to formation of a durable paint film.

3.2 SURFACE PREPARATION:

- A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.
- B. Remove 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 operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.
- C. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.
 - 1) Ferrous Metals: Clean ferrous surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning.
 - a) Touch-up shop-applied prime coats on frames, wherever damaged or bare, where required by other sections of these specifications. Clean and touch-up with same type shop primer.
 - 3) Plaster

- a) New plaster: Cure at least 30 days, unless higher pH is acceptable to manufacturer of coatings. If it is elected to proceed with painting earlier, provide appropriate surface preparation or surface conditioner.

3.3 MATERIALS PREPARATION:

- A. Mix and prepare painting materials in accordance with manufacturer's directions.
- B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, 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.

3.4 APPLICATION:

- A. General: Apply all coatings in accordance with manufacturer's directions, using only recommended materials and methods. Use type of applicators and techniques best suited for substrate and type of material being applied.
- B. All interior areas to be painted shall be dust-free and illuminated to no less than 1 watt per square foot.
- C. Final paint thickness recommended by manufacturer is only a minimum all paint systems shall totally cover and consistently hide the substrate upon which they are applied. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
- D. Paint surfaces behind movable equipment same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or cabinetry with prime coat only before final installation of equipment.
- E. Paint exposed-to-view mechanical, electrical, or plumbing equipment to match adjacent surfaces. Do not paint mechanical or electrical equipment on roofs or in mechanical rooms or yards.
- F. Omit first coat (primer) on metal surfaces which have been shop-primed, touch-up painted or prefinished, unless otherwise indicated.
- G. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1) Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

- H. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness as recommended by coating manufacturer, and to totally and consistently cover surface to which it is applied without gaps, skips, runs, and holidays.
- I. Prime Coats: Apply prime coat of material which is required to be painted or finished, and which has not been prime coated by others.
 - 1) Touch up previously primed surfaces that have been damaged prior to painting.
- J. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.
- K. 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 or other surface imperfections will not be acceptable.
- L. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3. CLEAN-UP AND PROTECTION:

- A. Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day and dispose of properly.
- B. Upon completion of painting work, clean window glass, pre-finished window frames, and other paint-spattered surfaces. Remove spattered paint by proper methods of cleaning and scraping, using care not to scratch or otherwise damage finished surfaces.
- C. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to the Architect.
- D. 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.
- E. Disposal of Waste Materials: Recycle waste paint and empty containers if possible. Do not dump paint or clean brushes in building drains or on the site.

END OF SECTION 099000

SECTION 101000 - SLIDING MARKERBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes horizontal sliding markerboard units with visual display boards of the following type:
 - 1. Porcelain enamel markerboards
 - 2. Accessories

- B. Coordinate for all necessary blocking and supports for tracks.

1.02 REFERENCED STANDARDS

- A. ASTM-E 4
- B. ASTM B221

1.03 SUBMITTALS

- A. Shop Drawings: Provide shop drawings for each horizontal sliding unit required.
- B. Product Data: Provide technical data for materials specified. Include Material Safety Data Sheets, when applicable.
- C. Samples:
 - 1. Manufacturer's color charts
 - 2. Composition samples of face, core, backing material and trim to illustrate finish, color and texture.

1.04 OPERATION MAINTENANCE

- A. Include data on regular cleaning, stain removal, and precautions.

1.0 QUALITY ASSURANCE

- A. Provide all items in this section as manufactured by:

Basis of Design: Claridge Products and
Equipment, Inc.
Phone: 0/ 43-2200
claridgeproducts.com

1.0 FIELD CONDITIONS

- A. Field measure prior to preparation of shop drawings and fabrication to ensure proper fit.

1.0 WARRANTY

- A. Submit a "Life of the Building" warranty, stating that under normal usage and maintenance, and when installed in accordance with manufacturer's instructions and recommendations, Claridge porcelain enamel steel chalkboards and markerboards are guaranteed for the life of the building. Guarantee covers replacement of defective boards but does not include cost of removal or reinstallation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

Horizontal Sliding Chalkboard units equal Claridge Products and Equipment, Inc.,

2.02 MATERIALS

A.. Horizontal Sliding Chalkboard/Markerboard Units

1. Series: Two-track
 - a. Sliding Panels and/or Back Panel - Writing surface:
 1. Porcelain enamel steel Markerboard.
 2. Sizes: As shown on drawings.
 3. Typical Arrangements: All panels white, two panels per unit front and back panel .
 4. Component Parts: Top mounted panels without housing.
- B. Metal Trim and Accessories: Provide aluminum extrusions as manufactured by Claridge Products and Equipment, Inc. Frame and exposed members shall be heavy gauge extruded aluminum and shall meet or exceed ASTM B221 Alloy Standards.
 1. Finish: Etched and anodized satin finish.
 2. Chalktrough: Standard continuous, solid type aluminum accessory tray with ribbed section and injection molded end closures.
- C. Color: White.
- D. Adhesive: As recommended by manufacturer.

2.03 FABRICATION

- A. Shop assembly: Provide Horizontal Sliding Units with all corners reinforced with angles to strengthen frame. Nylon ball bearing rollers at top of unit and nylon guide rollers at bottom of unit to be of sufficient size and number to eliminate vibration and provide smooth and quiet operation of the panels
 1. Porcelain Markerboard or Chalkboard:
 - a. Sliding Panels:
 1. Face Sheet: Porcelain Enamel Steel 24 ga. minimum
 2. Core: 1/2" honeycomb
 3. Backing: steel

PART 3 - EXECUTION

3.01 PROJECT CONDITIONS

- A. Verify before installation that interior moisture and temperature approximate normal occupied conditions.
- B. Verify that wall surfaces are prepared and ready to receive boards.

3.02 INSTALLATION

- A. Deliver factory built units completely assembled and of dimensions shown in details and in accordance with manufacturer's shop drawings as approved by the architect.
- B. Follow manufacturer's instructions for storage and handling of units before installation.
- C. Install level and plumb, keeping perimeter trim straight in accordance with manufacturer's recommendations.

- D. Do not install boards on damp walls or in damp and humid weather without heat in the building.

3.03 ADJUST AND CLEAN

- A. Verify that all accessories are installed as required for each unit.
- B. At completion of work, clean surfaces and trim in accordance with manufacturer's recommendations, leaving all materials ready for use.

END OF SECTION

SECTION FIRE EXTINGUISHERS AND CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Fire extinguishers.
 - 2. Fire extinguisher cabinets semi-recessed.
- B. Provide as shown on the drawings.

1.3 SUBMITTALS

- A. General: Submit product data for fire extinguishers and cabinets, including 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.

1.4 QUALITY ASSURANCE

- A. UL-Listed Products: Fire extinguishers shall be UL listed with UL listing mark for type, rating, and classification of extinguisher.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. General: Provide fire extinguishers for each cabinet and other locations indicated, in colors and finishes selected by Architect from manufacturer's standards that comply local codes.
- B. Multipurpose Dry Chemical Type: UL-rated 4:A- 0B:C, 10-lb nominal capacity, in enameled steel container with chrome-plated brass valves.

2.2 CABINET

- A. Construction: Manufacturer's standard box, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth. Miter and weld perimeter door frames.
 - 1. Cabinet equal of JL Companies Ambassador Series.

- B. Cabinet Mounting: Suitable for the following mounting conditions:
 - 1. Semi-recessed into partitions with 2-1/2" rolled trim returning to wall.
- C. Door and Trim Material and Construction: Manufacturer's standard door construction, of material indicated, coordinated with cabinet types and trim styles selected.
 - 1. Door and cabinet: Steel.
 - 2. Door Glazing: None, solid door.
 - 3. Lettering, vertical, FIRE EXTINGUISHER
- D. Door Hardware: Provide pull with roller catch and continuous hinge.

2.3 FINISHES FOR CABINETS, GENERAL

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

2.4 STEEL CABINET INTERIOR FINISHES:

- A. Surface Preparation: Solvent-clean surfaces complying with SSPS-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP (white metal blast cleaning) or SSPC-SP (pickling).
 - B. Factory-Priming for Field-Painted Finish: Apply shop primer immediately following surface preparation and pretreatment.
 - C. Baked-Enamel Finish: Immediately after cleaning and pretreatment, apply manufacturer's standard two-coat baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's instructions for applying and baking to achieve a minimum dry film thickness of 2.0 mils. Paint entire cabinet inside and out, color - white.
2. AED CABINET: 20 ga. cold-rolled steel with white powder coat finish interior and exterior. Surface mounted, 1' x 1' x .2". Magnetic door catch. Identification graphics. Standard alarm sounds when door is open or until switched off.

Equal HeartSmart by JL Industries, HST-CAB02-(P).

Provide 2 each, located in coordination with Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for thickness and framing for cabinets to verify cabinet depth and mounting prior to cabinet installation.

3.2 INSTALLATION

- A. Follow manufacturer's printed instructions for installation.

- B. Install equipment in locations and at mounting heights indicated or, if not indicated, at heights to comply with applicable regulations of governing authorities.
 - 1. Prepare recesses in walls for cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.

END OF SECTION 104413

SECTION 115310 - LABORATORY CASEWORK AND OTHER FURNISHINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wood Laboratory Casework
- B. Metal Laboratory Casework and Tables
- C. Cabinet Hardware
- D. Laboratory Work Surfaces
- E. Shelving Assemblies
- F. Cylinder Rack and Cylinder Restraint Assembly
- G. Pipe Drop Enclosure
- H. Drying Rack
- I. Bench Top Sleeves
- J. Grommets and Accessories
- K. Finish for Miscellaneous Wood Items
- L. Metal Fabrications
- M. Stainless Steel Fabrications
 - 1. Work Surfaces
 - 2. Laboratory Sinks
- N. Slotted Channel Framing (Strut)
- O. Sealant

1.2 RELATED SECTIONS

- A. Division 09: Flooring (wall base)
- B. Section 115313: Fume Hoods and Other Air Containment Units
- C. Section 115343: Laboratory Service Fittings and Fixtures
- D. Division 22: Plumbing
- E. Division 23: Heating, Ventilated, and Air Conditioning (HVAC)
- F. Division 26: Electrical
- G. Division 27: Communications

1.3 REFERENCES

- A. Architectural Woodwork Institute (AWI), Woodwork Institute (WI), and Architectural Woodwork Manufacturers Association of Canada (AWMAC): Architectural Woodwork Standards (AWS), Edition 1, October 2009.
- B. Builders Hardware Manufacturers Association: ANSI/BHMA A156.18-2006 American National Standard for Materials and Finishes, 2006.
- C. Hardwood Plywood & Veneer Association: ANSI/HPVA HP-1-2004 Standard for Hardwood and Decorative Plywood, 2004.
- D. National Hardwood Lumber Association: NHLA Rules for the Measurement & Inspection of Hardwood & Cypress, 2007.
- E. Scientific Equipment and Furniture Association: SEFA 2 Recommended Practices for the Installation of Scientific Laboratory Furniture and Equipment.
- F. Scientific Equipment and Furniture Association: SEFA 3 Recommended Practices for Work Surfaces.
- G. Scientific Equipment and Furniture Association: SEFA 8-W Recommended Practices for Laboratory Grade Wood Casework.
- H. Scientific Equipment and Furniture Association: SEFA 8-M Recommended Practices for Laboratory Grade Metal Casework.

1.4 BID SUBMITTALS

- A. Certification of Compliance: All bidders (including those listed in 2.01-A) must submit a compliance certification statement indicating that their bid includes products and installation which comply with every requirement of the project specifications and drawings (accounting for any RFI responses received during the bidding phase).
- B. Certification of Qualifications: All bidders must submit a certification of compliance with the Qualifications requirements outlined below. List specific project experience as evidence of compliance.
- C. Substitution Requests: All substitution requests for this scope of work in this section must be made during the bidding phase. No substitution requests will be considered post-bid.

1.5 SUBMITTALS

- A. Refer to General Conditions and Division 1 "Submittal Procedures" for submittal requirements. In addition to these requirements, provide submittal requirements specified herein.
- B. Submittal requirements:
 - 1. Submittal shall be prepared individually for this specification section. Arrange product data, drawings and information for submission in a complete set for this specification section.
 - a. Shop drawings and product data as applicable for required mockups may be submitted separately and should be expedited for submittal as soon as the contract is awarded.

2. Submittal shall contain complete data for all items of this specification section. Periodic or partial submittals of individual components within this specification section will be returned as incomplete and rejected.
 3. Submittals shall be organized by specification sequence with section and paragraph number identified.
 4. Equipment and components being proposed shall be clearly labeled with all options and accessories indicated and shall be for this specific project. All non-applicable items shall be deleted or struck.
 5. Product data submittals provided in PDF format shall consist of fully collated PDF files allowing for collated printing from a single file.
 6. Shop drawings shall meet the requirements of the Architectural Woodworking Standards (AWS), except in cases where stricter requirements are identified in this section.
- C. Materials List/Product Data: Submit complete materials list, including catalogue data, of all materials, equipment, and products for work in this section.
1. Product data shall not be duplicative or redundant with shop drawings. Do not include drawings in the product data submittal that are included in the shop drawings.
- D. Shop Drawings: Submit complete shop fabrication and installation drawings, including plans, elevations, sections, details and schedules.
1. Show relationship to adjoining materials and construction.
 2. Show seaming pattern layout of all joints in work surfaces.
 3. Shop Drawings shall be in the form of reproducible, PDF files, or photocopies, to scale, sheet size not to exceed 11 inches by 17 inches (A3).
 4. Shop drawing submittals provided in PDF format shall consist of fully collated files allowing for collated printing from a single file. Blueline prints are not acceptable.
- E. Approved Substitution/Approved Equal: In addition to the items required in Division 1, all substitution requests shall include item-by-item comparison of the proposed substitution to this project specification. A copy of the project specification shall be submitted, with each item and subsection of the project specification marked as "Comply" or "Not Comply." In any cases where "Not Comply" is indicated, an explanation of the relative advantages of the proposed design shall be provided.
1. Substitution shall not affect dimensions shown on Drawings.
 2. The Contractor shall pay for changes to the building design, including engineering design, detailing, utility and service requirements, and construction costs caused by the requested substitution.
 3. Substitutions shall have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
 4. Maintenance and service parts shall be locally available for the proposed substitution.
- F. Submit detailed anchorage and attachment drawings provided by a licensed Structural Engineer complying with applicable codes, regulations, and guidelines in the state of installation.
1. The Contractor shall verify as part of the Bidding phase that the existing structure has the capacity and configuration to allow attachments and support of products within this section. Modify attachment or support details as required to comply with applicable codes and coordinate with existing conditions.
- G. Samples: Accompanying Materials List, submit for Architect's approval two (2) samples of each type of specified finish and color range available for casework, laboratory work surfaces, painted steel fabrications, cabinet hardware, and shelving.

- H. Certifications/ Test Data: Submit certifications and test data as required elsewhere in this section, including SEFA structural performance test reports, and finish performance test reports.
- I. Operations/Maintenance Manuals: At project close-out, submit for Architect's review and Owner's use, complete operating and maintenance manuals that describe proper operating procedures, maintenance and replacement schedules, components parts list, and closest factory representative for components and service.
- J. Warranty: Submit manufacturer's warranty including any additional certifications as needed to meet the requirements specified.

1.6 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect work of this section before, during and after installation including installed work and materials of other trades.
- B. Replacement: Any damaged work shall be replaced, repaired and restored to original condition to the approval of the Architect at no additional cost or inconvenience to the Owner.

1.7 ENVIRONMENTAL CONDITIONS

- A. It is the responsibility of the general contractor or construction manager to provide appropriate environmental conditions within the laboratory spaces throughout the period of installation of wood and composite wood casework products until substantial completion of the project and turnover to the owner. The relative humidity standards as delineated by the Architectural Woodwork Standards should be followed.
 - 1. Humidity must be controlled between 25% and 55% in all areas where laboratory casework is stored and/or installed.
 - 2. The range of relative humidity change should not exceed 30 percentage points.
- B. It is the responsibility of the laboratory furniture subcontractor to assess building environmental conditions prior to the delivery and installation of laboratory casework. Wood laboratory casework shall not, under any circumstances, be installed in spaces which do not comply with the requirements outlined above.

1.8 QUALIFICATIONS

- A. Work in this section shall be manufactured by and installed by a company/companies having a minimum of eight years documented experience providing and installing products similar to those specified in laboratory applications; an established organization; and production facilities including all tools, equipment and special machinery necessary for specializing in the fabrication and installation of the type of products specified, with skilled personnel, factory trained workmen and an experienced engineering department. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified work of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.

1.9 WARRANTY

- A. All products shall be warranted to be free from defects in materials and workmanship for a period of five years following substantial completion. The manufacturer/ dealer/ subcontractor shall repair or replace any products (or parts thereof) that are found to be defective. Replacement will include any parts, labor, shipping, and travel expenses involved. Warranty replacement work must be scheduled in coordination with the Owner's academic/research schedule and may therefore require evening and/or weekend work.

PART 2 - PRODUCTS

2.1 WOOD LABORATORY CASEWORK

- A. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
1. CiF Lab Solutions, 53 Courtland Avenue, Vaughan, Ontario, Canada L4K 3T2 Tel: 905 738-5821.
 2. Diversified Woodcrafts, Inc., 300 South Krueger Street, Suring, WI 54174 Tel: 920 842-2136.
 3. ICScientific, 1865 Highway 641 North, Paris, TN 38242-8814 Tel: 731-642-4251.
 4. Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
 5. Mott Manufacturing Ltd., 452 Hardy Road, P.O. Box 1120, Brantford, ON, Canada N3T 5T3 Tel: 519 752-7825.
 6. Approved substitution.
- B. Quality Standards:
1. Wood casework shall comply with all requirements of AWS Custom Grade architectural cabinets, unless otherwise specified in this section.
- C. Design Requirements:
1. Door and drawer design: Square edged full flush overlay design with eased edges. Applied panels may be required in areas such as sink cabinets and knee spaces with pencil drawers to complete the flush construction. Reveals shall be within the ranges indicated below; however, they shall be consistent across a given project.
 - a. Reveal from top of door/drawer fronts to top of cabinet: 3/32 inch to 3/8 inch.
 - b. Reveal from bottom of door/drawer fronts to bottom of cabinet bottom panel: Flush.
 - c. Horizontal and vertical reveals between door and drawer fronts: 3/32 inch to 3/16 inch.
 - d. Vertical reveal between side of door and drawer fronts and the side of the cabinet: one-half of the typical horizontal and vertical reveal.
 2. Pulls on doors shall be mounted vertically and on drawers horizontally.
 3. Grain Pattern:
 - a. Vertical Matched Grain Pattern: Grain pattern on all exposed surfaces shall be vertical. Entire cabinet front must be cut from a single panel.
 4. Toe Kicks/ Toe Spaces:
 - a. All tall storage cabinets to have toe space to match base units.
 - b. Provide toe spaces at all fully-exposed sides of cabinets, including locations such as the end of island benches, the end of peninsula benches, and outside-corner cabinets. Toe spaces shall run continuously through all items such as knee opening side panels and end panels.
 5. Full-Flush Construction and Installation: All finished panels and surfaces shall be in the same plane as the front of cabinet doors/drawers to provide a true flush overlay appearance.

- a. Filler panels: Provide filler panels where casework units meet perpendicular walls to create a continuous appearance.
 - 1). Full-flush end-of-run filler panels are required at all conditions where the joint width is one inch or larger. At conditions where the joint width is less than one inch, filler panel should be flush with cabinet body.
 - b. Flush panels: Provide fixed fully-edgebanded flush panels at sink cabinets, knee opening drawer units, filler panels, and elsewhere, so that all finished panels are in the same plane as cabinet doors and drawers to provide a true flush overlay appearance.
 - c. Applied panels may be required in areas such as sink cabinets and knee spaces with pencil drawers to complete the flush construction.
 - d. At outside corners, align side panel of cabinet with the face of the door of adjacent cabinet.
 - e. At inside corners, mount filler panels flush with face of adjacent cabinet doors.
 - f. At open cabinets (without doors), at knee opening side panels, and similar conditions, align face of cabinet with face of adjacent cabinet door. Adjust the depth of the cabinet and toe kick accordingly.
 - g. Align other filler panels and applied panels with face of adjacent cabinet doors.
 - h. Align face of end panels and knee-opening side panels with face of adjacent cabinet doors.
 - i. Provide filler/ trim panels at locations where undercounter dishwashers or glasswashers are shown and the units provided do not completely fill the opening indicated.
 - j. Where knee openings are located against a wall, provide a side/end panel against the wall.
 - k. Filler panels shall follow the profile of toe kicks.
6. Extended Ends:
- a. At end-of-run base cabinets, provide extended end to cabinet to create closure to the wall without the use of filler panels. Extended end shall be edgebanded on front and bottom edges. Back edge shall be scribed to the wall with a tight hairline joint. Field-applied panels do not meet this requirement.
 - b. At ends of island benches and peninsula benches, provide a paired set of base cabinets, each with an extended end, resulting in a single joint. These extended end panels shall be edgebanded on the front and bottom edges and shall meet at a hairline joint. Applied panels do not meet this requirement.
7. Flush interiors: Set cupboard bottom flush with front-end facers. Surface mounted bottoms and offsets caused by front face frames that interfere with ease of cleaning are not acceptable.
8. Widths of drawer bodies in knee opening rails shall not be less than 18 inches (457 mm). As noted above, applied panel shall be provided to complete the flush construction on either side of the drawer head.
- D. Materials and Finishes:
- 1. Wood:
 - a. Definition of cabinet components by surface visibility:
 - 1). Exposed Surfaces:
 - a). Surfaces exposed when doors and drawers are closed.

- b). Surfaces visible when behind glass doors, including tops and bottoms of shelves.
 - c). All exterior surfaces of suspended casework.
 - d). Open units.
 - e). Bottoms of cabinets if 42 inches (1070 mm) or more above finished floor.
 - f). Tops of cabinets if less than 72 inches (1830 mm) above finished floor.
 - g). Front rail of web frames.
- 2). Semi-exposed surfaces:
- a). Surfaces that are visible when solid (opaque) doors are open or drawers are extended, including backs of doors.
 - b). Tops of cabinets 72 inches (1830 mm) or more above finished floor when visible from an upper level.
- 3). Unexposed surfaces:
- a). Surfaces not normally visible after installation with doors open and drawers extended.
 - b). Bottoms of cabinets less than 30 inches (750 mm) above finished floor.
 - c). Tops of cabinets over 78 inches (1980 mm) above finished floor and not visible from an upper level.
- b. Wood Species and Veneer Cut: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
- c. Maple:
- 1). Lumber:
 - a). Exposed and semi-exposed: Plain sawn Maple, NHLA Grade FAS.
 - b). Unexposed: Select grade hardwood of a species suitable for the specified purpose.
 - c). All lumber shall be clean and free of defects; kiln and air dried to uniform moisture content of 6 percent.
 - 2). Veneer:
 - a). Exposed: Plain sliced white select maple, grade A. Thickness: 1/50 inch (0.5 mm), minimum.
 - (1). Color and Matching:
 - (a). 100% sapwood, no heartwood allowed.
 - (b). Slight color streaks or marks.
 - (c). Slight color variation.
 - (d). No sharp contrast at veneer joints.
 - (2). Natural Characteristics:
 - (a). Small conspicuous burls: combined average not to exceed 4 per 10 square feet (1 m²).
 - (b). Conspicuous burl size: 3/8 inch (9.5 mm), maximum.

- (c). Conspicuous pin knots: combined average not to exceed 4 per 32 square feet (3 square meters). Maximum pin knot size – dark part: 1/8 inch (3.2mm). Maximum pin knot size – total: ¼ inch (6.4mm).
 - (d). Scattered sound repair knots, bark pockets: not allowed.
 - (e). Slight mineral streaks, worm tracks, cross bars and vine marks.
 - (3). Manufacturing Characteristics:
 - (a). Rough cut or ruptured grain is not allowed.
 - (b). Blended repaired tapering hairline Splits: two 1/16 inch (1.6 mm) by 6 inch (152 mm) on end panels only.
 - (4). Repairs: Small blending allowed.
 - (5). Flitch Width, Face Components: 5 inches minimum, except for outside components.
 - b). Semi-Exposed: Plain sliced white select maple Grade B sapwood – no heartwood allowed.
 - c). Unexposed: Plain sliced hardwood veneer.
 - d). Layup pattern: Slip matched.
2. Plywood
 - a. Typical, Unless Otherwise Noted: Hardwood Veneer Plywood
 - 1). Product shall be provided with hardwood face veneers as specified above.
 - 2). Plies:
 - a). ¾ inch (19 mm): minimum 7-ply, including face veneers.
 - b). 1 inch (25 mm): minimum 9-ply, including face veneer.
 - 3). Physical Properties:
 - a). Screwholding: 355 lb at face.
 - b). Average modulus of rupture: 7346 psi (50.65 N/mm²).
 - b. Drawer and Door Fronts: ANSI A208.1 M2 Grade Industrial Particleboard Core Plywood.
 - 1). Product shall be provided with hardwood face veneers as specified above.
 - 2). Plies:
 - a). 3-ply, including face veneers.
 - 3). Minimum Physical Properties:
 - a). Screwholding: 247 lbs at face, 225 pounds at edge.
 - b). Average modulus of rupture: 2,393 lb/in².
 - c). Modulus of elasticity: 398,900 lb/in².
 - d). Hardness: 500 lbs.
 - c. Drawer box back, front and sides: Finnish or Baltic Birch Plywood
3. Hardboard: Dry process S2S hardboard made from compressed exploded wood fibers.
4. Edgeband/Facer: 1/8 inch (3 mm) hardwood; species as described above.

5. Dowels: 8 mm, diameter, minimum, hardwood, laterally fluted with chamfered ends.
6. Glue: Type 2 or Type 3 water resistant glue with gluing done in clamps and jigs.
7. Finish for Wood Laboratory Components:
 - a. All wood components shall be fully sanded on all surfaces including the underside of exposed components, glazed door element inside edges, penetrations for the attachment of drawer heads, screws attaching adjacent cabinets, cutouts at grilles, and all other such locations. The final installation shall present no rough, splintered, or unfinished surfaces at any visible, exposed, semi-exposed, or touchable locations. This does not apply to components of surfaces which will be fully concealed in the final installation.
 - b. Finish processes (stains and finishes) shall be by means of compression spray or a UV roll coater, providing high-transfer efficiency low waste generation. Solvent applied coatings are not acceptable and will not be considered. Manufacturer shall supply documentation that waste generated during the finishing process, is a non-hazardous material, eliminating liquid waste disposal in landfills.
 - 1). Chemically Resistance Finish: Finish for all wood products shall be environmentally friendly, highly chemically resistant, water-borne, laboratory-grade finish that satisfies the requirements specified herein for chemical and durability resistance. A letter from a third-party validator, verifying independent test results, shall be submitted.
 - 2). Operator Protection: The application shall be convenient and easily mastered, in a custom spray booth. The finish process shall be cleanly contained and shall have no solvent odor, and shall be applied in an air-conditioned room.
 - 3). VOC Emissions: Water-borne finishes shall be sprayed and cured with a near zero (2.0 lbs. per gallon for 'clean finish') VOC (Volatile Organic Compounds) emissions.
 - 4). Offgasing: After all wood products have cooled from the curing ovens, the coating shall be firm and stable. No further emissions or "Offgasing/Decomposition" vapors shall occur at room temperature.
 - c. Manufacturer may use either of the following finish systems:
 - 1). Customized, high-solids, cross-linked, ultraviolet light (UV)-cured coating developed for durability, including abrasion, chemical, impact, and scratch resistance, for flat-line applications. Coatings shall have little or no VOCs.
 - 2). Chemical-resistant modified acrylic urethane finish with built-in UV blocker, or equal, applied over permanent wood stain.
 - d. Stain Color:
 - 1). To be selected by Architect from manufacturer's full published color range.
 - e. Application:
 - 1). Finish application and sequence shall be as recommended and designed by the manufacturer for a high quality, laboratory-grade wood casework finish.
 - 2). Preparation: Sand exposed and semi-exposed surfaces smooth, free from dirt and defects.
 - 3). Stain application: Apply stain of color selected to all exposed and semi-exposed casework surfaces. Apply in a manner to achieve a match with the selected color sample upon completion of application of the finish.

- 4). Finish application: Apply chemical resistant top finish to all stained surfaces. Apply to doors after any notching for hinges has been performed. Finished surfaces shall be even, water-clear and bright. Cloudy or muddy finishes carrying tinting pigments will not be acceptable.
8. Glass: Framed glass doors:
 - a. 1/8 inch (3mm) to 7/32 inch (5.5 mm) nominal tempered glass.
 - b. Without imperfections or marred surfaces.
 - c. All glass should have etched safety information, readable from outside the cabinet.
- E. Construction:
1. Base Cabinets:
 - a. Assembly: Dowel and/or mortise-and-tenon joinery secured with countersunk screws and pressure-glued.
 - b. Cabinet Top:
 - 1). Front rail of 3/4 inch plywood by 2 1/4 inches (57 mm) or 1 inch (25 mm) by 3 inches (76 mm) hardwood. Back rail: 3/4 inch plywood or hardwood, 3-3/4 inches tall.
 - c. Cabinet Bottom: 3/4 inch (19 mm) thick plywood. Set flush and join to cabinet end panels. Front edge shall be edgebanded.
 - d. Cabinets Ends/Sides and Backs Exposed to View from the Outside: 3/4 inch (19 mm) thick plywood.
 - 1). Side panels and end panels: edgeband front edge and bottom edge.
 - e. Cabinet Backs, Exposed-to-View from the Inside at Open Units and Units with Glazed Doors: 1/4 inch (19 mm) thick veneer core plywood.
 - f. Cabinet Back, Semi-Exposed and Unexposed:
 - 1). Removable hardboard, 1/4 inch (6 mm) thick, with no white melamine surface.
 - 2). Sink base back shall be half-height construction to allow for plumbing and sink waste connection.
 - 3). Provide vertically split back on drawer cabinets.
 - g. Cabinet Base: 3 3/4 inches (95 mm) by 3/4 inch (19 mm) front hardwood or veneer core plywood toe space rail, mounted between end panels, forming a 4 inch (102 mm) high by 3 inch (76 mm) deep toe space, closed to cupboard bottom. Secure rails to cabinet end panels.
 - h. Shelves: 1 inch (25 mm) thick full-depth, 9-ply hardwood plywood. Full-depth is defined as a shelf whose front edge is within 1/2 inch (13mm) of the face of the cabinet when the shelf is fully back in the cabinet.
 - 1). Front edge of shelves shall be edgebanded.
 - 2). Pull-Out Shelves: Construction shall be similar to drawer body mounted on a full-extension pull-out slide, with 1/2 inch (12mm) hardwood plywood bottom.
 - 3). Shelf Adjustment: All shelves shall be adjustable on 32 mm centers.
 - 4). Shelf Tolerance: Shelves shall fit into cabinets or into shelf supports with a tolerance of 1/16 inch per side maximum.

- i. Drawer construction:
 - 1). Drawer box back, front and sides shall be of ½ inch (13 mm), 9-ply Finnish or Baltic Birch veneer plywood, with eased top edge, finished with a Gloss Level 7 polyester acrylic finish. The top edges of the completed drawer bodies shall be very smooth to the touch and shall not present any rough or splintered surfaces. Drawers shall be a minimum of 18 inches front to back.
 - a). Sides shall be full height with 1 inch (25 mm) clearance to frame opening above.
 - b). Sides shall extend to within approximately 1/4 inch (6 mm) of frame opening below.
 - 2). Acceptable drawer joinery options:
 - a). Dowel: Glued under pressure; 32mm, minimum, dowel spacing to 4 inches (102 mm) high, 64 mm dowel spacing above 4 inches (102 mm).
 - b). Multiple Dovetail: Tight fitting and glued.
 - 3). Drawer bottom shall be Baltic Birch veneer plywood. Bottom shall be grooved into the 4 sided drawer box and sealed with hot melt glue process around entire drawer bottom perimeter.
 - a). Drawers up to 24 inches wide: 3/8 inch (9mm) thick 7-ply Baltic Birch veneer plywood.
 - b). Drawers greater than 24 inches wide: 1/2 inch (13 mm) thick 9-Ply Baltic Birch veneer plywood.
 - j. Door and Drawer Heads: shall be ¾ inch (19 mm) thick plywood with edgebanding. Edges shall be as specified previously in this section. Drawer heads shall be screwed to drawer box.
 - k. Flush Panels: As described in the Design Requirements section of this specification.
 - l. Vertical Dividers: Full height dividers shall be 1½ inch (38 mm) thick plywood.
 - m. Front Horizontal intermediate Rail: ¾ inch (19 mm) by 1½ inches (38 mm) exposed hardwood rail shall be provided between doors and drawers. For all drawer units at benches where service fitting connections are not accessible via an adjacent knee opening filler or cabinet filler panel, drawer units to be provided with Keku fasteners (Keku fasteners not required at other locations). The drawer unit intermediate horizontal and vertical box frames must be removable. These components shall be assembled with Keku suspension fittings as manufactured by Häfele America Co. or approved so these members are easily removable at any time with no special tools to gain access to concealed piped services behind.
 - n. Intermediate Back Rail: 1½ inch (38 mm) by ¾ inch (19 mm) hardwood lumber to accept hardboard security panel between drawers.
 - o. Security Panels: Provide hardboard security panels, 1/8 inch (3 mm) thick, in frames when keyed-different locks are specified, or where individual padlock hasps are indicated. Inset security panel into frame on all four sides.
2. Wall, upper and tall cases:
 - a. Shall be manufactured with materials and joinery methods as specified for base units, unless otherwise indicated.
 - b. Edgebanding:

- 1). Wall cabinets side panels: Edgeband front and bottom edges. Wall cabinet end panels: Edgeband front, bottom, and top edges.
 - 2). Edgeband front and top edges of upper cabinet side and end panels.
 - 3). Edgeband front, top, and bottom edges of tall cabinet side and end panels.
- c. Cabinet Interior Backs: 1/4 inch thick veneer core plywood, typical for all exposed, and semi-exposed interior backs.
 - d. Hardwood plywood tops: 1 inch (25 mm) thick with front edge edgebanded.
 - e. Wall and upper case hardwood plywood bottoms: 1 inch (25 mm) thick. Tall case hardwood plywood bottoms 3/4 inch (19 mm) thick. Edgeband front edges.
 - f. Bottom hardwood kick rail on tall cases: 3 3/4 inches (95 mm) by 3/4 inch (19 mm) front hardwood or veneer core plywood toe space rail, mounted between end panels, forming a 4 inch (102 mm) high by 2 1/2 inch (63 mm) deep toe space, closed to cupboard bottom. Secure rails to cabinet end panels.
 - g. Solid doors shall be the same construction as specified for base cabinets.
 - h. Framed-glazed doors: Hardwood construction, 3/4 inch (19 mm) by 2 3/4 inch (70 mm) machined to accept glass. Ease all edges, interior and exterior, including those that frame the glazing. Provide extruded vinyl retaining molding on interior designed so glass can be replaced without tools
 - i. Shelves: 1 inch (25 mm) thick full depth, 9-ply hardwood plywood. Full-depth is defined as a shelf whose front edge is within 1/2 inch (13mm) of the face of the cabinet when the shelf is fully back in the cabinet.
 - 1). Front edge of shelves shall be edgebanded.
 - 2). Front edge of open shelves:
 - a). Retainer Rail: Retainer rail as specified elsewhere in this section and detailed on drawings.
 - 3). Shelf adjustment:
 - a). Wall units: All shelves shall be adjustable on 32 mm centers.
 - b). General purpose tall units: Unless indicated otherwise provide one fixed shelf. All others shall be adjustable on 32 mm centers.
3. Aprons and leg assemblies:
 - a. Apron: Not less than 3/4 inch (19 mm) by 4-5/16 inch (110 mm) hardwood.
 - b. Legs: Not less than 2 inch (50 mm) by 2 inch (50 mm) hardwood.
 - 1). Leg clips at base of fixed legs as specified elsewhere in this Section.
 - c. Leg rails: Not less than 1 1/4 inch (32 mm) by 2 1/2 inch (63 mm) hardwood.
 - d. All exposed edges of legs and aprons shall be eased, sanded smooth, and finished per requirements described above for wood laboratory casework components.
 4. Fume Hood Cabinets:
 - a. Purpose-designed wood cabinet with fixed panel above door to conceal cup sink and plumbing.
 - b. Provide wood fume hood cabinets where adjacent cabinetry below a fume hood is wood.
 5. Wood Casework Construction Performance:

- a. Base cabinets shall be constructed to support a uniformly distributed load of 200 lbs. minimum per square foot (1000 kg/m²) of cabinet top area (total maximum of 2000 lbs. (900 kg)), including working surface, without permanent distortion or interference with door and drawer operation.
 - b. Base cabinets shall be constructed so that when supported on both back corners and one front corner; with a counterweight load of 350 pounds placed on the rear corner behind the supported front corner; and with a load of 200 pounds placed on the unsupported corner – there shall be no permanent damage after 24 hours of loading. Maximum allowable deflection shall not exceed 1/8 inch.
 - c. Swinging doors mounted on base units shall support a 200 lb. (113 kg) load located at a test point 12 inches (305 mm) measured horizontally from hinge along the top edge of door through a swing of 160 degrees. Weight test shall allow nominal temporary deflection, but no permanent distortion. Door assembly shall be twist-resistant and rigid, and shall close in a flat plane against the cabinet to permit the door catch at top of door to function properly.
 - d. Drawers shall be constructed so that they will support a 150 pound load hung on the drawer head centerline, with the drawer opened 13 inches (330mm), for five minutes. There shall be no interference with the normal operation of the drawer and the drawer head should remain tightly fastened to the drawer.
 - e. Drawers shall be constructed so that a drawer that is removed and supported on four corners will support a 10 pound sand or shot bag dropped from a height of 24 inches (610mm) without damage.
 - f. Drawers shall be constructed so that a drawer that is removed and supported at a 45 degree angle shall be capable of withstanding three impacts of a 2 inch (51mm) diameter, 12 inch (305mm) long steel rod (approximately 10 pounds in weight) released from 13 inches (330mm) from the front and back of the drawer. The drawer joinery shall remain intact and the drawer shall operate normally when placed back into the casework cabinet.
 - g. Drawer mechanical suspension systems shall be designed and attached to that a drawer uniformly loaded with 75 pounds of sand or shot bags shall operate freely without binding over its full range for 50,000 cycles at a rate not exceeding 10 cycles per minute. The force required to open and close the loaded drawer for the purposes of this test shall not exceed 8 pounds.
 - h. Shelves shall be designed and supported to that they can support a load of 40 pounds per square foot, up to a maximum of 200 pounds per shelf, for 24 hours with no more than 0.35 inches (9mm) of deflection maximum.
- F. Hardware: As specified elsewhere in this Section.
- G. Wood Finish Chemical Resistance Performance Requirements:
1. Manufacturer shall submit wood finish chemical resistance performance test results. Testing to be performed by independent testing agency.
 2. Procedure: Place panel on a flat surface, clean with soap and water and blot dry. Condition the panel for 48-hours at 73° +/- 3°F (23° +/- 2°C) and 50 +/- 5% relative humidity or the currently accepted guideline set by ASTM. Test the panel for chemical resistance using forty-nine different chemical reagents by one of the following methods. For both methods, leave the reagents on the panel for a period of one hour. Wash off the panel with water, clean with detergent and naphtha, and rinse with deionized water. Dry with a towel and evaluate after 24-hours at 73° +/- 3°F (23° +/- 2°C) and 50 +/- 5% relative humidity, or the currently accepted guideline set by ASTM.
 - a. Method A: Test volatile chemicals by placing a cotton ball saturated with reagent in the mouth of a 1 ounce (29.574cc) bottle and inverting the bottle on the surface of the panel.

- b. Method B: Test non-volatile chemicals by placing five drops of the reagent on the surface of the panel and covering with a 24mm watch glass, concave side down.
3. Rating System: Evaluations shall use the following rating system:

Level 0	No detectable change.
Level 1	Slight change in color or gloss.
Level 2	Slight surface etching or severe staining.
Level 3	Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

4. Acceptance Level:
- a. Individual test results for the specified 49 reagents shall be within the Range for that reagent as specified on the table below.
- b. There shall be no more than four (4) Level 3 conditions.
5. Table of reagents:

Test No.	Chemical Reagent	Test Method	Range
1.	Acetate, Amyl	A	0-1
2.	Acetate, Ethyl	A	0-1
3.	Acetic Acid, 98%	B	0-1
4.	Acetone	A	0
5.	Acid Dichromate, 5%	B	0-1
6.	Alcohol, Butyl	A	0-1
7.	Alcohol, Ethyl	A	0
8.	Alcohol, Methyl	A	0-1
9.	Ammonium Hydroxide, 28%	B	0-2
10.	Benzene	A	0-1
11.	Carbon Tetrachloride	A	0-1
12.	Chloroform	A	0
13.	Chromic Acid, 60%	B	0-1
14.	Cresol	A	0-2
15.	Dichloroacetic Acid	A	0-3
16.	Dimethylformamide	A	0-2
17.	Dioxane	A	0-1
18.	Ethyl Ether	A	0-1
19.	Formaldehyde, 37%	A	0
20.	Formic Acid, 90%	B	0-1
21.	Furfural	A	0-1
22.	Gasoline	A	0
23.	Hydrofluoric Acid, 37%	B	0-2
24.	Hydrofluoric Acid, 48%	B	0-2
25.	Hydrogen Peroxide, 30%	B	0-1
26.	Iodine, Tincture of	B	0-2
27.	Methyl Ethyl Ketone	A	0
28.	Methylene Chloride	A	0-1
29.	Monochlorobenzene	A	0-1
30.	Naphthalene	A	0
31.	Nitric Acid, 20%	B	0
32.	Nitric Acid, 30%	B	0-2
33.	Nitric Acid, 70%	B	2-3
34.	Phenol, 90%	A	0-2
35.	Phosphoric Acid, 85%	B	0-1
36.	Silver Nitrate Saturated	B	0-1

Test No.	Chemical Reagent	Test Method	Range
37.	Sodium Hydroxide 10%	B	0-2
38.	Sodium Hydroxide 20%	B	0-2
39.	Sodium Hydroxide 40%	B	0-2
40.	Sodium Hydroxide Flake	B	0
41.	Sodium Sulfide Saturated	B	0
42.	Sulfuric Acid, 33%	B	0-1
43.	Sulfuric Acid, 77%	B	0-1
44.	Sulfuric Acid, 96%	B	1-3
45.	Sulfuric Acid 77% & Nitric Acid 70% equal parts	B	1-3
46.	Toluene	A	0
47.	Trichloroethylene	A	0
48.	Xylene	A	0
49.	Zinc Chloride, Saturated	B	0

2.2 METAL LABORATORY CASEWORK AND TABLES

- A. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer. Corrosive and flammable liquid/solvent storage cabinets may also be provided by the manufacturers listed with their descriptions.

1. Laboratory Casework:

- a. Air Master Systems, 6480 Norton Center Drive, Muskegon, MI 49441 Tel 231 798-1111.
- b. Bedcolab Ltd, 2305 Francis Hughes Avenue, Laval, Quebec, Canada H7S 1H5 Tel 514 384-2820.
- c. CiF Lab Solutions, 53 Courtland Avenue, Vaughan, Ontario, Canada L4K 3T2 Tel: 905 738-5821.
- d. ICIScientific, 1865 Highway 641 North, Paris, TN 38242-8814 Tel: 731-642-4251.
- e. Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
- f. Mott Manufacturing Ltd., 452 Hardy Road, P.O. Box 1120, Brantford, ON, Canada N3T 5T3 Tel: 519 752-7825
- g. Approved substitution.

B. Metal Laboratory Casework

1. Design Requirements:

- a. Door and drawer front design: Full flush overlay metal construction with door and drawer fronts overlaying the case unit ends, top and bottom rails.
- b. Full-flush overlay design requirements:
 - 1). Applied panels may be required in areas such as sink cabinets and knee spaces with pencil drawers to complete the flush construction.
 - 2). Reveals shall be within the ranges indicated below – however, they shall be consistent across a given project.
 - a). Reveal from top of door/drawer fronts to top of cabinet: 3/32 inch to ¼ inch.
 - b). Reveal from bottom of door/drawer fronts to bottom of cabinet bottom panel: Flush.

- c). Horizontal and vertical reveals between door and drawer fronts: 3/32 inch to 3/16 inch.
 - d). Vertical reveal between side of door and drawer fronts and the side of the cabinet: one-half of the typical horizontal and vertical reveal.
- c. Pulls on doors shall be mounted vertically and on drawers horizontally.
 - d. All tall cases shall be provided with toe space to match base units.
 - e. All cabinets shall be constructed and finished to be suitable for use as stand-alone units and to permit future rearrangement without the need for additional parts or finish.
 - f. Widths of drawers in knee opening rails shall not be less than 24 inches (600 mm) or the width of the rail whichever is the lesser.
 - g. Cabinets below fume hoods that conflict with ductwork, cup sinks, or waste connections shall be 19 inches deep to accommodate any obstructions.
 - h. Full-Flush Construction and Installation: All finished panels shall be in the same plane to provide a true flush overlay appearance.
- 1). Filler panels:
 - a). Provide metal filler panels at inside corners, end-of-run conditions, and other similar locations, aligned with the face of adjacent metal cabinet bodies.
 - 2). Outside corners:
 - a). At outside corners, align side panel of cabinet with the face of the door of adjacent cabinet.
2. Materials:
- a. Steel: Cold-rolled furniture stock sheet steel, prime grade, roller leveled.
 - 1). Steel shall be treated at the mill to be free of scale, ragged edges, deep scratches, or other injurious effects.
 - 2). All gauges indicated are to be U.S. standard.
 - b. Glass: Framed glass doors:
 - 1). 1/8 inch (3mm) to 7/32 inch (5.5 mm) thick tempered glass.
 - 2). Without imperfections or marred surfaces.
 - 3). All glass should have etched safety information, readable from outside the cabinet.
3. Base, Wall, Upper, and Tall Cabinets:
- a. General:
 - 1). Exterior corners: shall be spot and arc welded with heavy back up reinforcement at exterior corners. All face joints shall be arc welded and ground smooth to provide a continuous flat plane.
 - 2). All units shall have a cleanable smooth interior. Front and rear posts, reinforcing members or channel uprights shall be enclosed full heights on all cabinet openings.
 - 3). End Uprights shall be formed into not less than a channel formation at top, bottom, back and front.

- 4). The edge of the vertical uprights shall be formed to provide a strike for doors and drawers, and shall be perforated for the support of drawer channels, intermediate rails and hinge screws.
 - 5). An upright filler shall be screwed in place in all cupboard units to close the back of the channel at front of the upright and to provide a smooth interior for the cupboard to facilitate cleaning.
 - 6). The upright filler shall be perforated with shelf adjustment holes at no more than ½ inch (12.7 mm) centers.
 - 7). The inside front of the upright shall be further reinforced with a full height 14 gauge (2.0 mm thick) hinge reinforcement angle.
 - 8). Die Formed Gussets: shall be furnished in each bottom corner of base units to insure rigidity, and a 3/8 inch (10 mm) -16 leveling bolt, 3 inches (75 mm) long, shall engage a clinch nut in each gusset. Each leveling bolt and gusset shall be capable of supporting 500 lbs (225 kg). (Each unit shall support 2000 lbs. (900 kg) uniformly distributed on a work top.) Provide caps at all penetrations provided to access leveling devices.
- b. Cabinet Base:
- 1). Case bottom and bottom rail shall be formed of one piece of metal except in corner units and shall have both sides and back formed up or down and shall be offset in front to provide a door and drawer recess rabbet.
 - 2). Toe Space Rail: shall extend up and forward to engage bottom rail to form a smooth surfaced toe space, 3 inches (75 mm) deep and 4 inches (100 mm) high. Whenever the base is omitted for units to be set on building bases or separate metal bases, the toe space rail shall extend back 4½ inches (115 mm).
- c. Cabinet Back, Unexposed: Cabinet back shall consist of a top and bottom rail, channel formed for maximum strength and welded to back and top flange of end uprights, with space between left open for access to plumbing lines. All units shall be provided with removable back panels.
- 1). Sink units shall be provided with fixed half-height backs to allow plumbing lines to enter and exit the cabinet through the open area.
- d. Shelves: shall be full depth formed down ¾ inch (19 mm), back 7/8 inch (22 mm) and up ¼ inch (6 mm) at front and rear and formed down at ends ¾ inch (19 mm). Shelves over 36 inches (914 mm) in length shall be additionally reinforced by a flanged channel shaped member electro-welded to underside of shelf. Shelves shall be adjustable. Full-depth is defined as a shelf whose front edge is within ½ inch (13mm) of the face of the cabinet when the shelf is fully back in the cabinet.
- 1). Restraint: At open shelf units, provide retainer rail as specified elsewhere in this section and detailed on drawings.
- e. Doors: shall be readily removable and hinges easily replaceable. Hinges shall be applied to the case and door with screws. Welding of hinges to either case or door will not be acceptable.
- f. Door and Drawer Heads:
- 1). Metal, Flush Overlay: shall be a two-piece sheet steel assembly of ¾ inch (19 mm) overall thickness to consist of an inner pan, an outer pan having a channel formation on all four sides, and the interior space filled with sound deadening at the time of assembly. Door Pans and Drawer Heads shall be painted inside and out prior to assembly.

- a). All four corners of door and drawer heads shall be welded closed and ground smooth to eliminate exposure of raw edges and open gaps.
 - b). Glazed Hinged Door Construction: Glazed swinging doors shall be 3/4 inch thick and consist of an inner and outer door pan welded to form a single unit. Outer door pan shall be 18 gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3 inches wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18 gauge steel, flanged at all four sides, pierced for a glass opening in center of the door, with 16 gauge hinge reinforcements welded in place. Glazing shall be held in place by a rubber or vinyl gasket around the entire edge of the glass. Outer door pan shall be prepared as necessary to accept attachment of pulls as specified elsewhere in this section.
- g. Drawer Construction:
- 1). Drawer bodies shall be made in one-piece construction including the bottom, two sides, back and inner front. They shall be fully coved at interior bottom on all four sides for easy cleaning. Sides shall be full height with 1/2 inch (13 mm) clearance to frame opening. Drawers shall be a minimum of 18 inches front to back.
 - 2). Drawer Suspension: Refer to Drawer Slides under Hardware section.
 - 3). Drawer stops: shall be provided to insure smooth, quiet operation at point of contact with cabinet front.
- h. Top Horizontal Rail: Provide on base cabinets such that rail shall interlock within the flange at top of end panels for strength. Reinforcements shall be provided at all front corners for additional welded strength between vertical and horizontal case members.
- 1). Top horizontal rail shall be flush at the face of the unit.
- i. Intermediate Rails: Provide on base cabinets such that rails shall be provided between doors and drawers, but shall not be provided between drawers unless made necessary by locks in drawers. When required, intermediate rails shall be recessed behind doors and drawer fronts, and designed so that security panels may be added as required.
- j. Intermediate Vertical Uprights: shall be furnished to enclose cupboards when used in a unit in combination with a half width bank of drawers. However, to allow storage of large or bulky objects, no upright of any type shall be used at the center of double door cupboard units.
- k. Security Panels: Provide security panels in frames between drawers and cabinets within a cabinet where keyed different locks are indicated.
- l. Knee Space Service Strip Cover Panels where specified, shall be 18 gauge (1.3 mm thick) steel, of the same finish as cabinets, and shall be furnished at open spaces under counter top where no cabinets occur. They shall be easily removable and shall cover piping from underside of top of service ledge to floor.
- m. Provide filler panels where required between cabinets, at corner intersections of cabinets, between cabinets and walls and wherever else required for a complete finished installation. For tall cabinets, filler panels shall be provided for vertical face and top. For wall cabinets, filler panels shall be provided for vertical face, top and bottom. Filler panels shall follow the profile of toe kicks.
4. Metal-Framed Laboratory Tables

- a. Tops: Refer to Laboratory Furnishing drawings for top materials, as described in the Laboratory Work Surfaces section.
 - 1). Tops shall be mechanically attached to the table frame with a minimum of six concealed metal angle brackets screwed into the inside of the table frame and the bottom of the work surface. Metal angle bracket may be stainless steel, zinc-coated steel, or powder-coated steel. Screws shall be dome-head, with a minimum size of No. 5, ½ inch long, or otherwise sufficient to firmly and permanently secure the benchtop to the table frame allowing that the table may be picked up by the top.
 - 2). Vibration absorbing isolation: Provide a continuous wide bead of clear silicone sealant to the top of all supporting rails. Allow complete cure before attachment of the work surface.
 - b. Leveling Glides and Leg Shoes:
 - 1). Each leg other than those fitted with casters shall have leveling glides: (2 inch) (48 mm) diameter, two-piece pivot construction, steel housing, non-marring, phenolic or translucent plastic insert, (1/2 inch) (12 mm) diameter, minimum (1 1/2 inch) (36 mm) long zinc plated stems. Each glide shall have a load bearing capacity of 150 lbs.
 - 2). Each leg other than those fitted with casters and adjustable-height legs, shall have leg shoes: Black coved vinyl or rubber leg shoe, 2 inches (50 mm) in height.
 - c. Construction:
 - 1). Table rails, legs, and spreader rails shall be fully welded into a single-piece table frame structure. Welds at all joints shall be continuous without gaps. Partially welded components without continuous welds will not be acceptable. Leg rails and spreaders shown on the drawings shall be fully welded to the legs with continuous welds without gaps. No mechanical joints between members are permitted.
 - d. Rails: Not less than 1½ inch by 4½ inch 16 gauge (38 by 114 by 1.6 mm) channel steel sections, reinforced as necessary for leg attachment.
 - e. Legs: Not less than 2 inch by 2 inch 16 gauge (50 by 50 by 1.6 mm) square tubular steel sections.
 - f. Leg rails and spreader rail: Not less than 1¼ inch by 2½ inch 16 gauge (32 by 63 by 1.6 mm) steel sections, reinforced as necessary for leg attachment.
 - g. Materials and Finish: Refer to Metal Fabrications specifications in this Section for material and finish requirements.
5. Aprons and leg assemblies:
 - a. Apron: Not less than 1½ inch (38 mm) by 4 inch (114 mm) 16 gauge (x 1.6 mm thick) channel steel sections, reinforced as necessary for leg attachment.
 - b. Legs: Not less than 2 inch (50 mm) by 2 inch (50 mm) 16 gauge (x 1.6 mm thick) square tubular steel sections.
 - c. Leg rails: Not less than 1¼ inch (32 mm) by 2½ inch (63 mm) 16 gauge (x 1.6 mm thick) steel sections, reinforced as necessary for leg attachment. Each leg shall have a recessed leveling screw and a black, coved vinyl or rubber leg shoe, 2 inches (50 mm) in height.
 6. Fume Hood Cabinets:

- a. Purpose-designed metal cabinet with fixed panel above door to conceal cup sink and plumbing.
 - b. Provide metal fume hood cabinets where adjacent cabinetry below a fume hood is also metal.
7. Corrosives Storage Cabinets:
- a. Manufacturers:
 - 1). Manufacturers of metal laboratory casework (base cabinets only).
 - 1). Air Master Systems, 6480 Norton Center Drive, Muskegon, MI 49441 Tel 231 798-1111.
 - 2). Justrite Manufacturing Company, 2454 Dempster St., Suite 300, Des Plaines, IL 60016 Tel: 800 798-9250.
 - 3). Approved substitution.
 - b. Purpose-designed lined metal cabinet.
 - c. Lining: Base cabinets may have either of the following two types of linings. Tall cabinets must only have Type 2 lining with a 100% seamless non-porous flame-coated thermoplastic liner.
 - 1). Type 1 Lining: Cabinet shall be complete lined with a polypropylene or polyethylene liner with sealed or seamless intersections between panels. Liner shall be the full depth of the cabinet. No metal of any type shall be exposed within the lined interior of the cabinet. Screw-heads, if required, shall be covered with hinged-type (not snap-on) plastic screw-head covers.
 - a). Shelf: Removable full-depth polypropylene or polyethylene shelf. Full-depth is defined as a shelf whose front edge is within ½ inch (13mm) of the face of the cabinet when the shelf is fully back in the cabinet.
 - 2). Type 2 Lining: All interior surfaces of the cabinet shall be coated with a 100% seamless non-porous flame-coated thermoplastic liner. Liner shall be applied to all interior walls, ceiling, sump, door interiors, and shelving. Basis of design: Plascore PPA-751, or Justrite Chemcor. No known equal.
 - a). Shelf: Removable adjustable full-depth metal shelf coated with lining material. Full-depth is defined as a shelf whose front edge is within ½ inch (13mm) of the face of the cabinet when the shelf is fully back in the cabinet.
 - (1). Provide the quantity of shelves as shown on drawings.
 - d. Label: "CORROSIVES" in conspicuous silk-screened lettering. Stick-on decals are not acceptable. Size and style of lettering shall match the Flammable Liquid/Solvent Storage Cabinet label. Lettering shall be 2 1/2 inches tall. Color of lettering shall be red. If cabinet color is red, lettering shall be yellow.
 - e. Locks: Cabinet doors shall be lockable. Lock shall have not metal parts exposed within the lined interior.
 - f. Venting:
 - 1). Cabinets below or adjacent to fume hoods: Provide and install 2 inch (50 mm) diameter schedule 40 PVC vent pipe and PVC fittings. Termination of vent pipe maybe one of the following:

- a). Extend vent pipe 4 inches (100 mm) above dished worktop, behind the baffle in the hood, as shown on the drawings. Provide hole through fume hood work surface above the corrosive storage cabinet to accommodate 2 inch (50 mm) diameter vent pipe. Seal gap around penetration with clear silicone sealant.
 - b). Extend vent pipe up within the fume hood side wall and vent through the hood side wall liner behind the upper portion of the fume hood baffle.
- 2). Cabinets not below or adjacent to fume hoods: Vent connection to exhaust duct system shall be under Division 23. Provide hole in back of cabinet to accept exhaust connection.
- g. Seismic Anchor: Provide seismic anchor for freestanding cabinets. Seismic anchors may be floor or wall attachments and shall not attach to adjacent casework or work surfaces. Seismic anchors shall be accessible without removal of laboratory casework, furnishings, or equipment.
8. Flammable Liquid/Solvent Storage Base Cabinets:
- a. Acceptable manufacturers:
 - 1). Bedcolab Ltd, 2305 Francis Hughes Avenue, Laval, Quebec, Canada H7S 1H5 Tel 514 384-2820.
 - 2). CiF Lab Solutions, 53 Courtland Avenue, Vaughan, Ontario, Canada L4K 3T2 Tel: 905 738-5821.
 - 3). Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
 - 4). Mott Manufacturing Ltd., 452 Hardy Road, P.O. Box 1120, Brantford, ON, Canada N3T 5T3 Tel: 519 752-7825.
 - 5). Approved substitution.
 - b. Purpose-designed double-walled metal cabinet for the storage of flammable, combustible and solvent liquids.
 - c. Cabinet doors: Well-fitting, metal, self-closing and self-latching with fusible lead links and door sequencer.
 - d. Label: "FLAMMABLE - KEEP FIRE AWAY" in conspicuous silk-screened lettering. Stick-on decals are not acceptable. Size and style of lettering shall match that of the Corrosive Storage Cabinet label. "FLAMMABLE" lettering shall be 2 1/2 inches tall. "KEEP FIRE AWAY" lettering shall be 2 inches tall. Color of lettering shall be red. If cabinet color is red, lettering shall be yellow.
 - e. Locks: Cabinet doors shall be lockable.
 - f. Floor pan: Provide a 2 inch (50 mm) deep liquid tight pan to cover the entire bottom of the cabinet to contain liquid leaks and spills.
 - g. Shelves: Provide heavy-duty full-depth metal shelves using pan-type construction to create a liquid-tight containment tray.
 - 1). Provide the quantity of shelves as shown on drawings.
 - h. Standards:
 - 1). Comply with the requirements of OSHA and NFPA 30.
 - 2). Comply with the requirements of Uniform Fire Code and the International Fire Code.
 - 3). Cabinets shall be certified and labelled with UL 1275 or FM 6050 labels.

- i. Flammable liquid/solvent storage base cabinets shall not be vented. Seal vent openings with bungs as provided by manufacturer.
 - j. Electrical grounding:
 - 1). Provide each flammable liquid / solvent storage base cabinet with an externally mounted grounding conductor screw terminal for up to No. 8 AWG conductor, mounted at the top of the cabinet.
 - 2). Connection from the equipment grounding bus at the lab branch circuit panel to the storage cabinet terminal shall be under Division 26.
9. Tall Flammable Liquid/Solvent Storage Cabinets:
- a. Manufacturers:
 - 1). Eagle Manufacturing Company, 2400 Charles St., Wellsburg, WV 26070
Tel: 304 737-3171.
 - 2). Justrite Manufacturing Company, 2454 Dempster St., Suite 300, Des Plaines, IL 60016
Tel: 800 798-9250.
 - 3). Approved substitution.
 - b. Purpose-designed double-walled metal cabinet for the storage of flammable, combustible and solvent liquids.
 - c. Cabinet doors: Well-fitting, metal, self-closing and self-latching with fusible lead links and door sequencer.
 - d. Label: "FLAMMABLE - KEEP FIRE AWAY" in conspicuous silk-screened lettering. Stick-on decals are not acceptable. Size and style of lettering shall match that of the Corrosive Storage Cabinet label. "FLAMMABLE" lettering shall be 2 1/2 inches tall. "KEEP FIRE AWAY" lettering shall be 2 inches tall. Color of lettering shall be red. If cabinet color is red, lettering shall be yellow.
 - e. Locks: Cabinet doors shall be lockable.
 - f. Floor pan: Provide a 2 inch (50 mm) deep liquid tight pan to cover the entire bottom of the cabinet to contain liquid leaks and spills.
 - g. Shelves: Provide heavy-duty full-depth metal shelves using pan-type construction to create a liquid-tight containment tray.
 - h. Standards:
 - 1). Comply with the requirements of OSHA and NFPA 30.
 - 2). Comply with the requirements of Uniform Fire Code and the International Fire Code.
 - 3). Cabinets shall be certified and labelled with UL 1275 or FM 6050 labels.
 - i. Tall flammable liquid/solvent storage cabinets shall be vented:
 - 1). Remove both metal bungs from cabinet outlets and replace with flash arrestors provided by manufacturer. Connection with 2 inch (50 mm) black iron vent piping to the HVAC systems as shown on LF drawings shall be under Division 23.
 - 2). Vents from multiple cabinets shall not be manifolded prior to connection to the building system.
 - j. Electrical grounding:
 - 1). Provide each flammable liquid / solvent storage cabinet with an externally mounted grounding conductor screw terminal for up to No. 8 AWG conductor, mounted at the top of the cabinet.

- 2). Connection from the equipment grounding bus at the lab branch circuit panel to the storage cabinet terminal shall be under Division 26.
 - k. Seismic Anchor: Provide seismic anchor for tall flammable liquid/solvent storage cabinets. Seismic anchors may be floor or wall attachments and shall not attach to adjacent casework or work surfaces. Seismic anchors shall be accessible without removal of laboratory casework, furnishings, or equipment. Anchor attachment shall not void UL listing.
10. Vacuum Pump Cabinets:
 - a. Provide metal vacuum pump cabinets at:
 - 1). Locations where vacuum pump cabinets are located below fume hoods, and adjacent cabinets below fume hoods are also metal.
 - 2). At other locations where indicated.
 - b. Label: "VACUUM PUMP" in conspicuous silk-screened lettering. Stick-on decals are not acceptable. Size and style of lettering shall match the Flammable Liquid/Solvent Storage Cabinet lettering. Lettering shall be 2 1/2 inches tall. Color of lettering shall be red. If cabinet color is red, lettering shall be yellow.
 - c. Venting:
 - 1). Exhaust connection will be by mechanical contractor. Provide flange for interface with exhaust duct.
 - 2). Provide air intake grille as specified elsewhere in this section.
 - d. Acoustical Lining: Cabinet shall be provided with sound absorption and thermal heat reflecting quilted liner on door back, interior cabinet top, and interior cabinet sides, and interior cabinet back.
 - 1). Manufacturer: Acoustical Solutions product ABBC-13; no known equal.
 - 2). Attach along perimeter at 6 inches on center, typical.
 - e. Cable/ vacuum line through port: Provide as specified elsewhere in this section.
 - f. Pump Support: Stainless steel pull out tray supported by 150 pound full-extension drawer slides, with a watertight polypropylene pan insert. Vibration isolation shall be provided between tray and watertight pan insert.
 - g. Electrical: Provide NEMA 5-20R receptacle mounted to inside back of cabinet installed under Division 11 with final connection under Division 26.
 - 1). Provide lit switch to control receptacle as indicated in drawings.
11. Metal Casework Construction Performance: Base cabinets shall be constructed to support a uniformly distributed load of 200 pounds. minimum per square foot (1000 kg/m²) of cabinet top area (total maximum of 2000 pounds (900 kg)), including working surface without objectionable distortion or interference with door and drawer operation.
 - a. Base cabinet corner gussets with leveling bolts shall support 500 pounds (225 kg) per corner, at 1½ inch (38 mm) projection of the leveling bolt below the gusset.
 - b. Each adjustable and fixed shelf 4 feet (1219 mm) or shorter in length shall support an evenly distributed load of 40 pounds per square foot (200 kgf/m²) up to a maximum of 200 pounds (90 kg), with nominal temporary deflection, but no permanent set.

- c. Drawer assemblies shall automatically maintain alignment in cabinet opening and shall not bind during opening or closing of the drawer so as to minimize glass breakage and damage to fragile parts.
 - d. Swinging doors mounted on base units shall support a 250 lb. (113 kg) load located at a test point 14 inches (356 mm) measured horizontally from hinge along the top edge of door through a swing of 180 degrees. Weight test shall allow nominal temporary deflection, but no permanent distortion. Door assembly shall be twist-resistant and rigid, and shall close in a flat plane against the cabinet to permit
- C. Hardware: As specified elsewhere in this Section.
- D. Metal Casework Color: As selected by the Architect from manufacturer's full color line and complying with finish requirements described below.
- E. Metal Casework Finish Requirements:
- 1. Paint finish for steel laboratory products shall utilize a dry coating process with minimal waste generation. Liquid-applied coatings shall not be acceptable. Manufacturer shall supply documentation that waste generated during the painting process, is a solid, non-hazardous material.
 - a. Pretreatment: Finish process shall incorporate a phosphate conversion coating during the pretreatment/cleaning operation.
 - b. Operator Protection: The painting process shall be cleanly contained, have no solvent odor and be performed in an air-conditioned room.
 - c. VOC (Volatile Organic Compounds) emissions shall not exceed 0.29 lbs per gallon (35 g/L).
 - d. Offgasing: No further emissions or "Offgasing/Decomposition" vapors shall occur at room temperature from installed finished parts.
 - 2. Preparation: After the units have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish to the metal and to aid in the prevention of corrosion. Physical and chemical cleaning of the metal shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a heated cleaner/phosphate solution and pretreated with iron phosphate spray followed by a neutral final seal prior to application of final finish. The strength of each solution shall be monitored by filtration to insure consistent quality. All treated parts shall be immediately dried in heated ovens and gradually cooled before application of the finish. Treated metal parts shall be clean and properly prepared to provide optimum adhesion of finish and resistance to corrosion.
 - 3. Application: Electrostatically apply powder coat of selected color and bake in controlled high temperature oven to assure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:
 - a. All surfaces, exterior or interior, exposed to view, shall receive sufficient powder coat to achieve an average 1.5 mil (38 μ m) film thickness with a minimum 1.2 mil (30 μ m) film thickness and shall have smooth satin luster.
 - b. Backs of cabinets and other surfaces not exposed to view shall have sufficient powder coat to achieve an average 1.0 mil (25 μ m) film thickness.
 - 4. All drawer bodies to be finished in matching color or in a uniform neutral color.
 - 5. Concealed interior parts shall receive corrosion-resistant treatment.
 - 6. Finish must be UV stable.
- F. Metal Finish Performance Requirements:

1. Manufacturer shall submit metal finish performance testing results. Testing to be performed by independent testing agency.
2. Chemical resistance:

a. Test procedure: Place samples on a flat surface, clean with soap and water and blot dry. Condition the panel for 48-hours at 73 +/- 3 degrees Fahrenheit (23(+ 2(C) and 50+ 5% relative humidity, or the currently accepted guideline set by ASTM. Test the samples for chemical resistance using forty-nine different chemical reagents by one of the following methods. For both methods, leave the reagents on the sample for a period of one hour. Wash off the sample with water, clean with detergent and naphtha, and rinse with deionized water. Dry with a towel and evaluate after 24-hours at 73 ± 3 degrees Fahrenheit (23°± 2°C) and 50± 5% relative humidity, or the currently accepted guideline set by ASTM

- 1). Method A: Test volatile chemicals by placing a cotton ball saturated with reagent in the mouth of a 1 ounce (29.574cc) bottle and inverting the bottle on the surface of the sample. The cotton ball shall remain in contact with the sample for the duration of the test.
- 2). Method B: Test non-volatile chemicals by placing five drops of the reagent on the surface of the sample and covering with a 24mm watch glass, convex side down.

b. Rating System: Evaluations shall use the following rating system:

Level 0	No detectable change.
Level 1	Slight change in color or gloss.
Level 2	Slight surface etching or severe staining.
Level 3	Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

c. Acceptance Level:

- 1). Individual test results for the specified 49 reagents shall be within the Range for that reagent as specified on the table below.
- 2). There shall be no more than four (4) Level 3 conditions.

d. Table of reagents:

Test No.	Chemical Reagent	Test Method	Range
1.	Acetate, Amyl	A	0-1
2.	Acetate, Ethyl	A	0-2
3.	Acetic Acid, 98%	B	0-3
4.	Acetone	A	0-1
5.	Acid Dichromate, 5%	B	0-1
6.	Alcohol, Butyl	A	0-1
7.	Alcohol, Ethyl	A	0-1
8.	Alcohol, Methyl	A	0-1
9.	Ammonium Hydroxide, 28%	B	0
10.	Benzene	A	0-2
11.	Carbon Tetrachloride	A	0-1
12.	Chloroform	A	0-2
13.	Chromic Acid, 60%	B	0-2
14.	Cresol	A	0-2
15.	Dichloroacetic Acid	A	0-3
16.	Dimethylformamide	A	0-2
17.	Dioxane	A	0-2

Test No.	Chemical Reagent	Test Method	Range
18.	Ethyl Ether	A	0-1
19.	Formaldehyde, 37%	A	0-1
20.	Formic Acid, 90%	B	0-3
21.	Furfural	A	0-3
22.	Gasoline	A	0
23.	Hydrofluoric Acid, 37%	B	0-2
24.	Hydrofluoric Acid, 48%	B	0-3
25.	Hydrogen Peroxide, 30%	B	0-1
26.	Iodine, Tincture of	B	0-2
27.	Methyl Ethyl Ketone	A	0-2
28.	Methylene Chloride	A	0-2
29.	Monochlorobenzene	A	0-2
30.	Naphthalene	A	0-1
31.	Nitric Acid, 20%	B	0-1
32.	Nitric Acid, 30%	B	0-1
33.	Nitric Acid, 70%	B	0-3
34.	Phenol, 90%	A	0-2
35.	Phosphoric Acid, 85%	B	0-1
36.	Silver Nitrate Saturated	B	0
37.	Sodium Hydroxide 10%	B	0
38.	Sodium Hydroxide 20%	B	0
39.	Sodium Hydroxide 40%	B	0-1
40.	Sodium Hydroxide Flake	B	0
41.	Sodium Sulfide Saturated	B	0
42.	Sulfuric Acid, 33%	B	0
43.	Sulfuric Acid, 77%	B	0
44.	Sulfuric Acid, 96%	B	2-3
45.	Sulfuric Acid 77% & Nitric Acid 70% equal parts	B	1-3
46.	Toluene	A	0-1
47.	Trichloroethylene	A	0-1
48.	Xylene	A	0-1
49.	Zinc Chloride, Saturated	B	0

3. Hot Water Test

- a. Test Procedure: 190 to 205 degrees Fahrenheit (88°C to 96°C) hot water shall be allowed to trickle (with a steady stream and at a rate of not less than 6 ounces (177.5 cc) per minute) on the finished surface, which shall be set at an angle of 45°, for a period of 5 minutes.
- b. Acceptance Level: After cooling and wiping dry, the finish shall show no visible effect from the hot water.

4. Paint Adhesion on Steel Test

- a. Test Procedure: Test shall be based on ASTM D2197-86 "Standard Method of Test for Adhesion of Organic Coating." Two sets of eleven parallel lines 1/16 inch (1.587 mm) apart shall be cut with a razor blade to intersect at right angles thus forming a grid to 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. Brush surface lightly with a soft brush for one minute. Examine under 100 fc (1076 lux) of illumination.
- b. Acceptance Level: Ninety or more of the squares shall show finish intact.

5. Impact Test

- a. Test Procedure: Drop a 1 pound (0.4536 kg) ball (approximately 2 inch (50.8 mm) diameter from a distance of 12 inches (305 mm) onto a flat horizontal surface, coated to manufacturer's standard manufacturing method.
 - b. Acceptance Level: No visual evidence to the naked eye of cracks in the finish due to impact.
6. Paint Hardness on Steel Test
- a. Test Procedure: Paint film shall be tested with pencils of various hardnesses. Pencils shall have a wide, sharp edge. Pencils shall be pushed across surface in a chisel-like manner.
 - b. Acceptance Level: Finish film shall not rupture from a sharpened 4H pencil.

2.3 CABINET HARDWARE

- A. General: Special cabinets, such as corrosives storage and flammable liquid and solvent storage may be provided with the manufacturer's standard hardware.
1. All door and drawer pulls shall match, regardless of type of casework, except for:
 - a. Flammable liquid/ solvent storage cabinets, which should use manufacturer's standard latch handles as required to satisfy requirements of regulatory approvals.
 2. All hardware shall be compliant with the ADA Standards for Accessible Design (28 CFR Part 36).
- B. Drawer and Hinged Door Pulls:
1. Manufacturers:
 - a. Engineered Products Company (EPCO), P.O. Box 108, Flint, MI 48501-0108 Tel: 888 414-3726, www.EpcoHardware.com
 - b. Hafele America Co., 3901 Cheyenne Drive, Archdale, NC 27263 Tel: 800 423-3531, www.Hafele.com
 - c. Rockford Process Control, LLC, 2020 Seventh Street, Rockford, IL 61104 Tel: 815 966-2000, www.RockfordProcessHingesAndHardware.com
 - d. US Futaba, 2901 West Garry Avenue, Santa Ana, CA 92704 Tel: 800 821-4007, www.usfutaba.com
 - e. Approved substitution.
 2. Drawer and door pulls shall attach to door or drawer with machine screws. Two (2) pulls shall be furnished on drawers wider than 28 inches (711 mm). Plastic pulls or other types subject to breakage are not acceptable.
 3. Type: Pulls shall be round "wire."
 - a. Material and Finish:
 - 1). Stainless steel with finish as follows:
 - a). BHMA 630 Satin (Previously US32D).
 - b. Size:
 - 1). Length: 4 inches (100 mm) center to center of screw holes.
 - 2). Diameter: ¼ inch (6 mm).

C. Hinges:

1. General: Hinges shall be attached to both door and case with three screws through each leaf. Provide two hinges for doors up to 48 inches (1219 mm) high; three hinges for doors over 48 inches (1219 mm) high.
 2. Type: Institutional with a five-knuckle bullet-type barrel. Characteristics:
 - a. Height: 2½ inches (63 mm), nominal.
 - b. Material: Stainless steel with stainless steel screws.
 - 1). Finish:
 - a). BHMA 630 Satin (Previously US32D).
 - 2). Manufacturers:
 - a). Hafele America Co., 3901 Cheyenne Drive, Archdale, NC 27263 Tel: 800 423-3531.
 - b). Rockford Process Control, Inc. 202 Seventh St., Rockford, IL 61104 Tel: 815 966-2000.
 - c). Approved substitution.
- D. Shelf Hardware:
1. Shelf Supports:
 - a. Adjustable shelf supports: Heavy-duty double pin clear plastic shelf support with lockdown clips.
 - 1). Basis of Design: Hafele heavy duty shelf support.
 2. Manufacturers:
 - a. Bainbridge Manufacturing, Inc., P.O. Box 487, 237 W 3rd, Waterville, WA 98858 Tel: 800 255-4702.
 - b. The Engineered Products Company (Epc), P.O. Box 108, Flint, MI 48501 Tel: 313 767-2050.
 - c. Hafele America Co., 3901 Cheyenne Drive, Archdale, NC 27263 Tel: 800 423-3531
 - d. Knap & Vogt Manufacturing CO., 2700 Oak Industrial Dr. NE, Grand Rapids, MI 49505 Tel: 616 459-7620.
 - e. Sugatsune America, Inc. 221 East Selandia Lane, Carson, CA 90746 Tel: 310 329-6373.
 - f. Approved substitution.
- E. Catches:
1. Roller Catches:
 - a. Types and Materials: Roller catches shall be one of the following types. All-plastic or knuckle-type catches are not acceptable, except at corrosive storage cabinets.
 - 1). Tension ball catches consisting of a case with an adjustable-tension ball catch and a matching strike. Components shall be either stainless steel, chrome plated zinc alloy, or chrome-plated brass.
 - 2). Nylon roller housed in a steel case, which catches on a steel strike plate. Steel components shall be zinc finished.
 - 3). At metal casework base cupboard, catches may consist of a two-piece heavy-duty cam action positive catch positioned near the pivoting edge of

- door which provides a clean unobstructed opening. Main body of the catch shall be confined within an integral cabinet divider rail, while latching post shall be mounted on the hinge side of door.
- 4). At corrosive storage cabinets, catches shall be non-metallic.
- b. Application: Provide roller catches at top of all cabinet doors without elbow catches, or as indicated.
 - 1). Tall Cabinets: Unless otherwise indicated locate roller catches at the fixed, center shelf.
 - 2). Wall Cabinets: Unless otherwise indicated locate roller catches at the bottom of cabinet door.
 - c. Manufacturers:
 - 1). The Engineered Products Company (Epc), P.O. Box 108, Flint, MI 48501 Tel: 313 767-2050.
 - 2). Sugatsune America, Inc. 221 East Selandia Lane, Carson, CA 90746 Tel: 310 329-6373.
 - 3). Approved substitution.
2. Elbow catches: Heavy-duty, adjustable, spring-type elbow catch and strike plate.
 - a. Material: Brass or steel with bright chromium plated finish.
 - b. Application: Elbow catches shall be used on left hand doors of locked double door cabinets, including tall cabinets.
 - 1). At tall cabinets, elbow catch shall latch to fixed center shelf. Latching devices using chains or strings are not acceptable.
 - c. Manufacturers:
 - 1). The Engineered Products Company (Epc), P.O. Box 108, Flint, MI 48501 Tel: 313 767-2050.
 - 2). Approved substitution.
- F. Drawer slides:
1. Typical: Ball bearing slides:
 - a. Material:
 - 1). Clear, zinc-coated steel.
 - b. Full extension, 100 lb/pr. (45 kg/pr.) capacity: Accuride 3832, Fulterer FR5000, or equal.
 - c. File drawers shall be equipped with rail mounted with overtravel, 150 lb/pr. (68 kg/pr.) capacity: Accuride 4034, Fulterer 5755, or equal.
 - d. Pull-out shelf suspension: 100 lb/pr. (45 kg/pr.) capacity pull-out shelf slide: Accuride 322, or equal.
- G. Drawer Stops: All regular drawers shall be equipped with integral stops to prevent drawer head impact with cabinet body.
- H. Door Stops: Provide door stops for any cabinet door, which will strike an obstruction when opened between 90 and 135 degrees.

1. Stop to be either:
 - a. Sash chain, No. 30 zinc-plated steel.
 - 1). Terminations: Zinc chromate wire screw eyes. Open eye as required to attach stop with screws. Through-bolting not allowed.
 - b. Coated cable.
 - 1). Seven-strand, 7-wire-per-strand, stainless steel cable with clear nylon coating.
 - 2). Wire diameter: 0.047 inches.
 - 3). Composite diameter with coating: 0.063 inches.
 - 4). Terminations: Number 10 stake eye on both ends. Attach to door/cabinet with screws. Through-bolting not allowed.
 - 5). McMaster Carr part number 30345T3 or equivalent.
 2. Engineer stop to length to allow door to open 1 ½ inch (40 mm) from obstruction.
- I. Hanging File Suspension System: Hangers shall be fastened and secured to drawer construction and shall not be freestanding units set inside the drawer. Provide in all file drawers.
1. Basis of Design: Blum Metafile Hanging File Frame Kit.
 2. Manufacturers:
 - a. Julius Blum, Inc. 7733 Old Plank Rd., Stanley, NC 28164 Tel: 800 438-6788.
 - b. Hettich America L. P., 6225 Shiloh Rd., Alpharetta, GA 30005 Tel: 800 438-8424.
 - c. Approved substitution.
- J. Label holders: Provide label holders, pinned in place. Stick-on holders not acceptable. Label holders shall be provided at all file drawers, and elsewhere as shown on drawings.
1. Size:
 - a. Minimum Size: 1 inch (25mm) by 2 inches (50mm)
 - b. Maximum Size: 2 inches (50mm) by 3 ½ inches (90mm)
 2. Material and finish:
 - a. Steel with matt chrome finish.
 3. Basis of Design Product:
 - a. 704ANO Label Holder by Knape & Voght, 2700 Oak Industrial Drive NE, Grand Rapids, MI 49505 Tel: 800 253-1561.
 - b. Approved substitution.
- K. Number Plates: Provide 5/8 inch (16 mm) by 1 ¼ inches (32 mm) aluminum number plates with black numbers, pinned in place. Stick-on holders not acceptable. Number plates shall be provided at all drawers where indicated on the plans. Number drawers sequentially in each laboratory.
- L. Locks:
1. General: Provide locks on all file cabinet drawers. Provide locks at other locations as indicated on the drawings.
 2. Lock type: Deadbolt-type lock.

- a. Disc-tumbler-type locks and cam-type locks are unacceptable.
 - b. Refer to Elbow Catches section, above, for requirements at two-swinging-door cabinets.
3. Testing requirements:
 - a. Locks shall comply with ANSI/BHMA standard E07121.
 - b. Lock shall be cycle tested per ANSI/BHMA A156.11 Grade 1.
4. Include spacers, adapters, fasteners, and strikes.
 - a. All locks shall strike into metal material. Striking directly into wood is not acceptable.
5. Barrel length shall be coordinated with specific conditions.
6. Finish: Locks shall have satin nickel or satin chrome finish.
7. Keying:
 - a. Key quantities: Provide two keys per lock. Provide four copies of any master/ grand master keys.
 - b. Key system:
 - 1). Key system shall support a minimum of 2000 different keys.
 - 2). Key system shall support up to three levels of master keys (grand-master keys, master keys, and sub-master keys) in addition to individual keys.
 - c. Key cylinder type:
 - 1). Coordinate key type with owner.
 - d. Key schedule: Coordinate key schedule with Owner.
8. Key engraving:
 - a. Keys to be engraved with an identification number corresponding to the layout of unique keys on the project. All identical keys shall be engraved with the same number.
9. Manufacturers:
 - a. Swinging Doors and Drawers:
 - 1). Illinois Lock Company, 301 West Hintz Rd., Wheeling, IL 60090 Tel: 847 537-1800.
 - 2). National Cabinet Lock, 200 Old Mill Rd., P.O. Box 200, Mauldin, South Carolina 29662 Tel: 864 297-6655.
 - 3). Olympus Lock, Inc. 18424 Highway 99, Lynnwood, Washington 98037 Tel: 206 362-3290.
 - 4). Approved substitution.
- M. Padlock Hasps: Provide one of the following:
 1. Stainless steel padlock-eye cam-type locking device and strike plate at cabinet locations as indicated on the drawings. Strike plate, or protection plate, shall be large enough to prevent padlock from damaging door or drawer front.
 2. Barrel-style cam-type padlock hasp sized to fit standard lock cylinder hole with finish to match drawer pulls, and strike plate at cabinet locations as indicated on the drawings.

- Strike plate, or protection plate, shall be large enough to prevent padlock from damaging door or drawer front.
3. Cam-lock shall engage or strike into a metal casting.
 4. Manufacturers:
 - a. Northeast Lock Corporation, 48 Oak St., Clifton, NJ 07014 Tel: 800 524-2575.
 - b. Olympus Lock, Inc. 18424 Highway 99, Lynnwood, Washington 98037 Tel: 206 362-3290.
 - c. Rockford Process Control, Inc. 202 Seventh St., Rockford, IL 61104 Tel: 815 966-2000.
 - d. Approved substitution.
- N. Glides: Non-marring material, 1 inch (25 mm) diameter, minimum, with a minimum of least 5/8 inch (16 mm) vertical adjustment. Provide on movable tables and mobile casework, unless otherwise indicated.
- O. Leveling devices: Where indicated, provide a 3/8 inch (10 mm) minimum diameter leveling bolt and floor clip.
- P. Leg shoes: Leg shoes shall be provided on all legs and table legs to conceal leveling devices, except for tables with casters. Shoes shall be 2 ½ (63 mm) inch high and of black rubber or pliable black vinyl material. Use of a leg shoe which does not conceal leveling device is not acceptable.
- Q. Floor clips: Provide fixed leg assemblies and fixed table legs with floor clips securely fastened to the floor after shimming.
- R. Support Struts and Service Ledging: Refer to specifications for slotted channel framing in this Section.

2.4 LABORATORY WORK SURFACES

- A. Epoxy Resin:
1. Manufacturers: Products complying with this specification may be provided by the following manufacturers.
 - a. American Epoxy Scientific, 500 East 16th Street, Mountain Home, AR 72653 Tel: 870-425-7777.
 - b. Durcon Laboratory Tops, Inc., 206 Allison Drive, Taylor, TX 76574 Tel: 512 595-8000.
 - c. Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
 - d. Approved substitution.
 2. Thickness:
 - a. Typical work surface: 1 inch (25 mm).
 - b. Fume hood work surfaces: Tops shall be 1¼ (32 mm) inches thick at outer edge, indented minimum ¼ inch (6 mm) to provide a raised rim around all exposed edges 1 inch (25 mm) wide, minimum, or as to allow for the fume hood sash. The front top edge of the raised rim and exposed vertical corners of the top shall be rounded or chamfered to a 1/8 inch (3 mm) radius. The juncture between the raised rim and the top surface shall be coved or chamfered to a ¼ inch (6 mm) radius.
 - c. Curbs and Splashes: 1 inch (25 mm).

3. Color:
 - a. Black.
 - b. Color sample to be approved by Architect before work is put in hand.

4. Description:
 - a. Monolithic filled epoxy resin work surface consisting of a polymerized cast resin material oven-cured in molds.
 - b. Overhangs: As noted on the plans.
 - c. Drip Grooves: Provide under all work surface exposed edges, unless noted otherwise on the Laboratory Furnishing Drawings. Drip grooves shall be ½ inch (13 mm) from the front edge where the top overhangs 1 inch (25 mm) and 3/8 inch (9.5 mm) from the edge where the edge overhangs 3/4 inch (19 mm).
 - d. Edge profile: For all exposed upper edges and corners:
 - 1). Bevel eased: 1/8 inch (3 mm) machined bevel with blended radius corners.
 - e. Marine edges: Where indicated on the Laboratory Furnishing Drawings, shall be 1 inch (25 mm) wide and ¼ inch (6 mm) high with chamfered or radiused transition to and be an integral part of the work surface.
 - f. Sink Mounting:
 - 1). Drop-in Sink Cutouts: Cutouts shall be profiled to provide support for the sink, and to ensure that the rim of the installed sink is 1/8 inch (3 mm) below the surrounding work surface level or bottom of drain grooves, if present. The top edge of the cutout shall have 1/8 inch (3 mm) bevel. Ensure that there shall be no gaps between the installed sink rim and work surface.
 - g. Curbs and Splashes:
 - 1). Height: 4 inches (100 mm), unless noted otherwise on Laboratory Furnishing Drawings.
 - 2). Bonded to the surface of the top to form a square joint.
 - h. Provide all holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Verify size of opening with actual size of equipment to be used prior to making openings. Form inside corners to a radius of not less than 1/8 inch (3 mm). After sawing, rout and file cutouts to ensure smooth, crack-free edges. Seal exposed edges after cutting with a waterproofing material recommended by the manufacturer.
 - i. Provide full-length, one-piece tops and backsplashes wherever possible, and keep field joints to an absolute minimum.

5. Physical Properties:
 - a. Chemical resistance:
 - 1). Organic solvents: A cotton ball, saturated with the test chemical, is placed in a one ounce bottle with a reservoir of liquid above the ball. The container is inverted on the test material surface for a period of 24 hours. Test temperature: 23°C ±2°C.
 - 2). Other test chemicals: Five drops (1/4 cc) of the test chemical are placed on the test material surface. The chemical is covered with a 1 inch diameter watch glass for a period of 24 hours. Test temperature: 23°C ±2°C.

- 3). Evaluation: After 24 hours exposure, exposed areas are washed with water, then a detergent solution, finally with naphtha, then rinsed with distilled water, dried with a cloth, and rated as follows:

0	No effect	No detectable change in the material surface.
1	Excellent	Slight detectable change in color or gloss but no change in function or life of the surface.
2	Good	A clearly discernable change in color or gloss but no significant impairment of surface life or function.
3	Fair	Objectionable change in appearance due to discoloration or etch, possibly resulting in deterioration of function over an extended period of time.
4	Failure	Pitting, cratering, or erosion of the surface. Obvious and significant deterioration.

- 4). Test results:

Test chemical	Concentration	Concentration			
		Black	Dark gray	Light gray	Beige
Chromic acid	40%	3	2	2	2
Hydrochloric acid	10%	0	0	0	0
Hydrochloric acid (conc.)	37%	0	0	0	0
Nitric acid	40%	0	0	0	0
Nitric acid (conc.)	70%	0	0	0	0
Sulfuric acid	60%	0	0	0	0
Sulfuric acid (conc.)	96%	4	4	4	4
Acetic acid	5%	0	0	0	0
Acetic acid (glacial)		0	0	0	0
Citric acid	1%	0	0	0	0
Oleic acid		0	0	0	0
Phenol solution	5%	0	0	0	0
Ammonium hydroxide	10%	0	0	0	0
Sodium carbonate sol.	20%	0	0	0	0
Sodium hydroxide sol.	60%	0	0	0	0
Sodium hypochlorite sol.	4%	0	0	0	0
Acetone		1	1	1	1
Benzene		1	1	1	1
Carbon tetrachloride		1	1	0	0
Diethyl ether		0	0	1	1
Dimethyl formamide		0	0	0	0
Ethyl acetate		0	1	1	0
Ethyl alcohol	95%	0	0	0	0
Ethylene dichloride		0	0	0	0
Heptane		0	0	1	0
Isooctane		0	0	0	0
Kerosene		0	0	0	0
Methyl alcohol		0	0	0	0

Test chemical	Concentration	Color			
		Black	Dark gray	Light gray	Beige
Toluene		0	0	0	0
Aniline		0	0	0	0
Mineral oil		0	0	0	0
Olive oil		0	0	0	0
Soap solution	1%	0	0	0	0
Transformer oil		0	0	0	0
Turpentine		0	0	0	0

b. Heat resistance:

- 1). High temperature test: A porcelain crucible is heated to a dull red color, placed on the test material, and allowed to cool to ambient temperature. Result: No observable surface deformation.
- 2). Flame test: A 3/8 inch (10 mm) Bunsen burner is adjusted to a quiet flame with a 1½ inch (38 mm) inner cone, overturned on the test material, and allowed to stay for 5 minutes. Result: no observable surface deformation.

c. Physical properties:

Compressive strength	ASTM D695	31,400 psi (216 MPa)
Tensile strength	ASTM D638	8,000 psi (55 MPa)
Flexural strength	ASTM D790	11,700 psi (81 MPa)
Rockwell hardness "M"	ASTM D785	105-110
Specific density	ASTM D792	122.4 lb/ft ³ (1960 kg/m ³)
Water absorption	ASTM D570	0.01%
Fire Resistance	ASTM D635	ATB (sec)=0
Heat deflection @ 264 psi (1.82 MPa)	ASTM D648	205°F (172°C)

B. Stainless Steel: Refer to Stainless Steel Fabrications section of this specification.

2.5 SHELVING ASSEMBLIES

A. Metal Shelving: Provide 18 gauge steel shelves with integral seismic lip and hat-section stiffener. Provide 16 gauge bookend brackets. Rear of bracket shall be profiled to fit into slots of shelf support. Refer to detail on Laboratory Furnishings Drawings.

B. High-Pressure Decorative (Plastic) Laminate Shelving:

1. Manufacturers/Facing material: Products complying with this specification may be provided by the following manufacturers.
 - a. Nevamar Decorative Surfaces, One Nevamar Place, Hampton, SC 29924 Tel: 800 638-4380.
 - b. Pionite Decorative Surfaces, One Pionite Road, P.O. Box 1014, Auburn, ME 04211 Tel: 800 746-6483.
 - c. Wilsonart International, 2400 Wilson Place, P.O. Box 6110, Temple, TX 76503 Tel: 800 433-3222.

- d. Approved substitution (no known equal).
- 2. Approved Products:
 - a. Nevamar ChemArmor.
 - b. Pionite ChemGuard.
 - c. Wilsonart ChemSurf
- 3. Color: To be selected by Architect.
- 4. Description:
 - a. High-pressure decorative laminate, meeting or exceeding NEMA Standard LD3 2005 Grade HGP, HGL, or HGS requirements, consisting of a resin formulation applied over the decorative surface paper to achieve chemical resistance. The decorative paper shall be treated with melamine resin, and the core shall consist of kraft papers impregnated with phenolic resin. Sheets shall be bonded under high temperature and pressure. Product shall be developed for casework, work surface, and shelving surfaces in laboratories.
 - b. Laminate shall be applied to top and bottom surfaces.
 - c. Finish: Fine pebble-grained "crystal" texture or matte texture with slight sheen to minimize smudges and finger marks, and to provide optimum scratch resistance.
 - 1). Gloss: 15-16 +/- 3 gloss units.
 - d. Physical Properties:
 - 1). Reference Standard: Plastic laminates shall meet or exceed ANSI/NEMA Specification LD3-2005 as specified herein.
 - 2). Minimum Thickness: 0.038 inches ± 0.005 inches (0.97 mm ± 0.13 mm).
 - 3). Cleanability: 10 cycles (NEMA LD3 test method 3.4).
 - 4). Boiling Water Resistance: No effect (NEMA LD3 test method 3.5).
 - 5). High Temperature Resistance: Slight effect (NEMA LD3 test method 3.6).
 - 6). Scratch Resistance: 4.5 Newtons (NEMA LD3 test method 3.7).
 - 7). Ball Impact Resistance: 60 inches (1524 mm) (NEMA LD3 test method 3.8).
 - 8). Radiant Heat Resistance: 200 sec (NEMA LD3 test method 3.10).
 - 9). Dimensional change:
 - 10). Machine direction: 0.50% (NEMA LD3 test method 3.11).
 - 11). Cross direction: 0.80% (NEMA LD3 test method 3.11).
 - 12). Wear resistance: 1,500 cycles, min. (black); 700 cycles, min. (other colors) (NEMA LD3 test method 3.13).
 - 13). Blister Resistance: 70 sec (NEMA LD3 test method 3.15).
 - 14). Stain Resistance Performance Test Results: The surface shall show essentially no effect on Black (Lab grade) plastic laminate when left in contact for 16 hours either when reagents were kept covered or allowed to evaporate.

0	No effect	No detectable change in the material surface.
1	Excellent	Slight detectable change in color or gloss but no change in function or life of the surface.
2	Good	A clearly discernable change in color or gloss but no significant impairment of surface life or function.
3	Fair	Objectionable change in appearance due to discoloration or etch, possibly resulting in

4	Failure	deterioration of function over an extended period of time. Pitting, cratering, or erosion of the surface. Obvious and significant deterioration.
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Acids

	Concentration	Rating
Acetic acid	All	0
Aqua regia		0
Chromic trioxide (Chromic acid cleaning solution)		1
Glacial acetic acid	99%	0
Hydrochloric acid	All	0
Hydrofluoric acid	48%	0
Formic acid	All	0
Nitric acid	All	3
Sulfuric acid	All	0
Perchloric acid (concentrated)		0
Phosphoric acid	All	0
Picric acid	1.2%	0
Tannic acid (saturated)		0
Uric acid (saturated)		0

Alkalis

Ammonium hydroxide	All	0
Sodium hydroxide	All	3
Sodium sulfide	15%	0

Solvents

Acetone		0
Amyl acetate		0
Amyl alcohol		0
Butyl alcohol		0
Carbon disulfide		0
Carbon tetrachloride		0
Chlorobenzene		0
Chloroform		0
Cresol		0
Dimethylformamide		0
Dioxane		0
EDTA		0
Ethyl acetate		0
Ethyl alcohol		0
Formaldehyde		0
Methanol		0

Solvents		
Methyl ethyl ketone		0
Methylene chloride		0
n-Hexane		0
Naphthalene		0
Phenol		0
Tetrahydrofuran		0
Toluene		0
Trichlorethane		0
Xylene		0
General Reagents		
Alconox (lab detergent)		0
Aluminon		0
Ammonium phosphate		0
Aromatic ammonia		0
Benedicts solution		0
Calcium hypochlorite (concentrated)		0
Camphorated parachlorophenol		1
Cellosolve		0
Copper sulfate		0
Ethylene glycol		0
Eucalyptol		0
Formalin		0
Gasoline		0
Hydrogen peroxide	3%	0
Iodine		0
Karl Fisher Reagent		0
Kerosene		0
Lactated ringers		0
Lysol		0
Methyl methacrylate		0
Mineral Oil		0
Monsel's solution (Ferric subsulfate)		0
Naphtha		0
Petroleum jelly		0
Phosphate buffered saline (PBS)		0
Pine oil		0
Potassium permanganate		0
Povidone iodine		0
Procaine		0
Quaternary ammonia compounds		0
Silver nitrate		0
Sodium azide		0
Sodium chromate		0
Sodium hypochlorite	5%	0
Sodium thiocyanate		0
Sucrose	50%	0
Thymol & Alcohol		0
Tincture of Iodine		0
Tincture of Mercurochrome		0
Tincture of Merthiolate		0
Trisodium phosphate	30%	0

General Reagents	
Urea	0
Vegetable oils	0
Water	0
Zephiran chloride	0
Zinc chloride	0
Zinc oxide ointment	0

Stains and Indicators	
Ag Eosin Bluish 5% in Alcohol	0
Bromothymol Blue	0
Cresol Red	0
Crystal Violet	0
Gentian Violet	1% 0
Gram Stains	0
Malachite Green	0
Methyl Orange	0
Methyl Red	0
Methylene Blue	0
Nigrosine	0
Safranin O	0
Sudan III	0
Thymol Blue	0
Wright's Blood Stain	0

5. Plastic laminate adhesive: High-pressure decorative laminate shall be bonded to core with thermosetting resorcinol or phenol-resorcinol adhesive, or as recommended by the manufacturer for the application, at temperature above 65°F (18.3°C) at a pressure no less than 15 pounds per square inch. Laminate core is not to exceed 10% moisture content and is to be laminated and cured in a controlled environment between 45% and 60% RH.
6. Core material: Hardwood Veneer Plywood.
 - a. Description: A one step calibrated core +/- .5mm (to avoid voids) with type 1 waterproof nauf glue. Grade 2 face, and back of mill choice plywood veneer.
 - b. Thickness/Plyies:
 - 1). 1 inch (25 mm): minimum 9-ply.
 - c. Physical Properties:
 - 1). Average modulus of rupture: 7346 psi (50.65 N/mm²).
 - 2). Face Screw Holding Strength: 355 lbf (1579 N).
7. Edging:
 - a. Unless otherwise indicated, all edges shall be edgebanded with 3 mm PVC edge banding set in hot melt adhesive. Adhesive shall have a minimum softening point of 150°F (65.6°C). Apply primer to substrate when recommended by adhesive manufacturer. Contact cement is not acceptable. Color of edgebanding to be selected by the Architect.

C. Safety Edges:

1. Types:

- a. Retainer Rail: ¼ inch (6 mm) diameter stainless steel retainer rail, as indicated on the drawings.
 - b. Extended Height PVC Band: 2 inch high set in hot melt adhesive. Adhesive shall have a minimum softening point of 150°F (65.6°C). Apply primer to substrate when recommended by adhesive manufacturer. Contact cement is not acceptable.
2. Refer to the description of each system below for locations of each type.
- D. Reagent Shelves with Fixed Tubular Supports.
1. Shelving: High-Pressure Decorative Laminate shelving as specified above.
 2. Shelf supports shall be Type 304 stainless steel tubing, ASTM A312, 1 inch (25 mm) outside diameter, 0.133 inch (3.4 mm) wall thickness, with 1/4 inch (6 mm) thick welded steel threaded inserts as shown on drawings.
 3. Fasteners shall be slotted, flat head, zinc screws with bolts as shown on drawings.
 4. Electrical raceway supports shall be 1/4 inch (6 mm) diameter stainless steel "U" bolt, provide one at each shelf support as indicated on drawings.
 5. Safety edging:
 - a. Provide safety edging at all four edges of overall installation. Do not provide safety edging at intermediate butt joints.
 - b. Extended height PVC band.
 6. Load capacity: System shall support a minimum of 25 pounds per square foot. Maximum deflection shall be 0.35 inches (9mm) under load.
- E. Adjustable Island Bench Shelves with a steel tube support system.
1. Shelving: Metal shelving as specified above.
 2. Steel Frame Support System: Provide cold rolled steel tube vertical and horizontal support members with radiused edges. All members shall be welded together. Grind all welds smooth and polish to produce clean smooth appearance with no visual evidence of welds after paint is applied. All vertical members shall be one piece continuous from floor to underside of structure above or to top horizontal member as indicated on the drawings. Horizontal top and intermediate members shall be one piece between vertical members. Provide welded caps at all open ends of tube sections. Secure vertical members to floor slab, underside of benchtop, if indicated on the drawings, and to underside of structure above.
 - a. Tube steel dimensions:
 - 1). 2 inches by 2 inches, 12 gauge (50 by 50 by 2.8 mm).
 3. Shelf standards:
 - a. Steel tubes shall be punched to receive adjustable shelf brackets. Pattern shall match Knape & Vogt 85 ANO series uprights, length in accordance with drawings.
 4. Shelf Brackets: 16 gauge (1.6 mm thick) bookend type, as detailed on drawings.
 5. Safety edging:
 - a. Front Edge:
 - 1). Retainer rail.
 - b. Rear edge:

- 1). Retainer rail.
 6. Load capacity: System shall support a minimum of 35 pounds per square foot applied at all shelves simultaneously. Maximum deflection shall be 0.35 inches (9mm) under load.
 7. Finish: Factory-finish steel tube support system, shelf standards, and brackets with epoxy powder coating. Color to be selected by the Architect.
- F. Adjustable Wall Shelves:
1. Shelving: Metal shelving as specified above.
 2. Double Slot Shelf Standards:
 - a. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
 - 1). Knape & Vogt Manufacturing Company, 2700 Oak Industrial Drive NE, Grand Rapids, MI 49505 Tel: 616 459-3311.
 - 2). Approved substitution.
 - b. Basis of Design: Knape & Vogt 85 ANO series uprights, or equal. Length as indicated on the drawings.
 3. Shelf Brackets: 16 gauge (1.6 mm) bookend type, as detailed on drawings.
 4. Safety edging:
 - a. Front Edge:
 - 1). Retainer rail.
 5. Load capacity: System shall support a minimum of 35 pounds per square foot applied at all shelves simultaneously. Maximum deflection shall be 0.35 inches (9mm) under load.
 6. Finish: Factory finish standards and brackets with epoxy powder coating. Color to be selected by the Architect.
- G. Chemical Resistant Shelf Units:
1. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
 - a. InterMetro Industries Corporation, 651 North Washington St., Wilkes-Barre, PA 18705 Tel: 800 992-1776. Manufacturer of Metro product range.
 - b. Eagle Group, 100 Industrial Blvd., Clayton, DE 19938 Tel: 302 653-3000.
 - c. Approved substitution.
 2. Description: Chemical-resistant polymer shelving, posts, components and accessories.
 3. Basis of Design: MetroMax storage system, floor-mounted post supported, or equivalent.
 - a. Posts: floor mounted polymer posts, adjustable at 1 inch (25 mm), minimum, increments, length as shown on drawings, Metro PE series or equal.
 - b. Shelves: Open grid design with post connectors, Metro GX2 series or equal.
 - 1). Provide solid shelf mat, Metro FX2 series or equal.
 - c. Provide diagonal bracing for lateral stability at freestanding applications.
 - d. Accessories:

- 1). Foot Plate: stainless steel with adjustable leveling bolt for polymer shelving, Metro No. 9993S or equal.
- 2). Post Clamps: Zinc-plated, to join adjacent polymer posts, Metro No. 9994Z or equal.
- 3). Shelf Ledges: Stackable, 2 inch (51 mm) high polymer, Metro No. LxxxX-2S or equal, sized to match shelf.

2.6 CYLINDER RACKS AND RESTRAINT ASSEMBLIES

A. Cylinder Rack Assembly:

1. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
 - a. Karan and Associates, Inc., 13181 Santa Ana Ave., Fontana CA 92337 Tel: 909-967-1104.
 - b. Kumar Industries, 4775 Chino Avenue, Chino, CA 91710 Tel: 909 591-0722.
 - a. Matheson Tri-Gas, 166 Keystone Drive, Montgomeryville, PA 18936 Tel: 215 648-4000.
 - b. Safe-T-Rack Systems, Inc., 4325 Dominguez Rd., Suite A, Rocklin, CA 95677 Tel: 800 344-0619.
 - a. Scott Specialty Gases, Inc., 6141 Easton Road Box 310, Plumsteadville, PA 18949 Tel: 215 766-8861.
 - b. Approved substitution.
2. Frame members: 2 inches by 2 inches by 1/8 inch (50 by 50 by 3 mm) square steel tube.
3. Construction: Refer to the Laboratory Furnishings drawings for details. Construction to be fully welded. Weld cover plates to close exposed tube ends. Grind and polish all welds to produce smooth surface with no visible evidence of welding when painted. Sizing:
 - a. Size typical units to accommodate standard-size laboratory gas cylinders.
 - b. Where shown on drawings, size units to accommodate liquefied gas dewars.
4. Chain: Provide restrainers of 5/16 inch diameter, Type 304 stainless steel welded chain fitted with stainless steel snap shackle with swivel clevis and split ring for each bracket; McMaster-Carr Supply Company, Suncor Marine & Industrial, Inc., or approved substitution.
5. Cylinder rack steel components shall be factory-finished to match the casework metal color as selected for the project.

B. Cylinder Restraint Assembly:

1. Framing channel, Fittings, Swivel Hangers, and End Caps: Slotted channel framing as specified elsewhere on this Section.
2. Provide two swivel hangers per cylinder or dewar per wall bracket
3. Sizing:
 - a. Size typical units to accommodate standard-size laboratory gas cylinders.
 - b. Where shown on drawings, size units to accommodate liquefied gas dewars.
4. Chain: Provide restrainers of 5/16 inch diameter, Type 304 stainless steel welded chain fitted with stainless steel snap shackle with swivel clevis and split ring for each bracket; McMaster-Carr Supply Company, Suncor Marine & Industrial, Inc., or approved substitution.

5. Cylinder restraint steel components shall be factory-finished to match the casework metal color as selected for the project.

2.7 PIPE DROP ENCLOSURE

- A. Fabricate pipe drop enclosures from minimum 18 gauge (1.3 mm thick) galvanized steel, per details shown on the Laboratory Furnishing drawings, except as noted.
 1. Pipe drop enclosures at the following locations shall be fabricated of 18 gauge, Type 304 stainless steel with a No. 4 finish:
 - a. At stainless steel counters.
- B. Seal all joints between dissimilar metals and at all panel seams with clear silicone sealant.
- C. Materials and finish shall be as specified under Metals Fabrications in this Section.

2.8 DRYING RACK

- A. Epoxy Drying Rack:
 1. Comply with requirements for molded epoxy resin specified under Laboratory Tops in this Section and as described herein.
 2. Drying rack bodies shall be of one inch (25 mm) thick black epoxy with a 3/16 inch to ¼ inch (5 to 6 mm) radius on all edges and corners. Each rack shall be of the size and with the peg arrangement shown on the Laboratory Furnishing drawings.
 3. Pegs shall be of injection molded white polypropylene. Pegs shall not be bonded into the body, but shall be held in position by mechanical design.
 4. Provide a drip trough of Type 304 stainless steel with a 16 gauge (1.6 mm thick), Type 304 stainless steel screen of 14 by 14 (1.8 by 1.8 mm) mesh, .02 (0.05 mm) wire.
 5. Provide stainless steel fixing screws of appropriate type for attachment to support structure.
 6. Provide clear, tight-fitting hose to drain from drip tray into sink.

2.9 BENCH TOP SLEEVES

- A. Provide 3 inch (75 mm) diameter sleeve of Type 304 stainless steel with No. 4 finish at bench tops as located and detailed on the Laboratory Furnishings drawings.

2.10 GROMMETS AND ACCESSORIES

- A. Round Grommets:
 1. Manufacturers: Products complying with this specification may be provided by the following manufacturers.
 - a. Doug Mockett & Company, Inc., Box 3333, Manhattan Beach, CA 90266 Tel: 800 523-1269.
 - b. Häfele America Inc., 3901 Cheyenne Dr., P.O. Box 4000, Archdale, NC 27263 Tel: 336 889-2322.
 - c. Approved equal.
 2. Basis of Design: Doug Mockett & Co., Inc. Model No. TG-3.
 3. Size: 2 3/8 inch (60 mm) outside diameter.
 4. Material: Plastic
 5. Accessories: Removable slotted plastic cover
 6. Color: To be selected by Architect.

7. Refer to floor plans for location.

B. Backpack Hook

1. Manufacturer: Sagatsune America, 18101 Savarona Way Carson, CA 90746 Tel: 310 329-6373
2. Basis of Design: Model EU-72 Fork Hook as manufactured by Sagatsune America.
3. Description: Type 316 stainless steel double hook with 66 pound load capacity.
 - a. Finish: Polished.
4. Provide blocking or backing plate at hook mounting locations as required to prevent to casework.

C. Grilles

1. Air intake grilles: Perforated metal mesh in a metal frame.
2. Sizes: As shown on drawings.
3. Mesh Pattern: Mesh 1.
4. Color: Factory-applied light gray paint.
5. Basis of Design Model: Doug Mockett & Co., Inc. GT Series Grilles.
 - a. Manufacturer: Doug Mockett & Co., Inc. P.O. Box 3333, Manhattan Beach, CA 90266 Tel 800 523-1269 or approved equal.

2.11 FINISH FOR MISCELLANEOUS WOOD ITEMS

A. Applicability: This section applies to wood fabrications, including, but not limited to, wood laboratory tables, wood-framed balance tables, wood-framed pegboards, and wood filler panels.

B. Finish:

1. Manufacturer may use either of the following finish systems:
 - a. Customized, high-solids, cross-linked, ultraviolet light (UV)-cured coating developed for durability, including abrasion, chemical, impact, and scratch resistance, for flat-line applications. Coatings shall have little or no VOCs. Chemical-resistant modified acrylic urethane finish with built-in UV blocker, or equal, applied over permanent wood stain.
2. Stain Color:
 - a. To be selected by Architect from manufacturer's full published color range.
3. Application:
 - a. Finish application and sequence shall be as recommended and designed by the manufacturer for a high quality, laboratory-grade wood casework finish.
 - b. Preparation: Sand exposed surfaces smooth, free from dirt and defects.
 - c. Stain application: Apply stain of color selected to all exposed casework surfaces. Apply in a manner to achieve a match with the selected color sample upon completion of application of the finish.
 - d. Finish application: Apply top finish to all stained surfaces. Finished surfaces shall be even, water-clear and bright. Cloudy or muddy finishes carrying tinting pigments will not be acceptable.
 - e. Stain Color:

- 1). To be selected by Architect from manufacturer's full published color range.

C. Wood Finish Chemical Resistance Performance Requirements:

1. Manufacturer shall submit wood finish chemical resistance performance test results. Testing to be performed by independent testing agency.
2. Procedure: Place panel on a flat surface, clean with soap and water and blot dry. Condition the panel for 48 hours at 73 +/- 3 degrees Fahrenheit (23° +/- 2°C) and 50 +/- 5% relative humidity or the currently accepted guideline set by ASTM. Test the panel for chemical resistance using forty-nine different chemical reagents by one of the following methods. For both methods, leave the reagents on the panel for a period of one hour. Wash off the panel with water, clean with detergent and naphtha, and rinse with deionized water. Dry with a towel and evaluate after 24-hours at 73° +/- 3°F (23° +/- 2°C) and 50 +/- 5% relative humidity, or the currently accepted guideline set by ASTM.
 - a. Method A: Test volatile chemicals by placing a cotton ball saturated with reagent in the mouth of a one-ounce (29.574cc) bottle and inverting the bottle on the surface of the panel.
 - b. Method B: Test non-volatile chemicals by placing five drops of the reagent on the surface of the panel and covering with a 24mm watch glass, concave side down.
3. Rating System: Evaluations shall use the following rating system:

Level 0	No detectable change.
Level 1	Slight change in color or gloss.
Level 2	Slight surface etching or severe staining.
Level 3	Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

4. Acceptance Level:
 - a. Individual test results for the specified 49 reagents shall be within the Range for that reagent as specified on the table below.
 - b. There shall be no more than four (4) Level 3 conditions.
5. Table of reagents:

Test No.	Chemical Reagent	Test Method	Range
1.	Acetate, Amyl	A	0-1
2.	Acetate, Ethyl	A	0-1
3.	Acetic Acid, 98%	B	0-1
4.	Acetone	A	0
5.	Acid Dichromate, 5%	B	0-1
6.	Alcohol, Butyl	A	0-1
7.	Alcohol, Ethyl	A	0
8.	Alcohol, Methyl	A	0-1
9.	Ammonium Hydroxide, 28%	B	0-2
10.	Benzene	A	0-1
11.	Carbon Tetrachloride	A	0-1
12.	Chloroform	A	0
13.	Chromic Acid, 60%	B	0-1
14.	Cresol	A	0-2
15.	Dichloroacetic Acid	A	0-3
16.	Dimethylformamide	A	0-2
17.	Dioxane	A	0-1
18.	Ethyl Ether	A	0-1

Test No.	Chemical Reagent	Test Method	Range
19.	Formaldehyde, 37%	A	0
20.	Formic Acid, 90%	B	0-1
21.	Furfural	A	0-1
22.	Gasoline	A	0
23.	Hydrofluoric Acid, 37%	B	0-2
24.	Hydrofluoric Acid, 48%	B	0-2
25.	Hydrogen Peroxide, 30%	B	0-1
26.	Iodine, Tincture of	B	0-2
27.	Methyl Ethyl Ketone	A	0
28.	Methylene Chloride	A	0-1
29.	Monochlorobenzene	A	0-1
30.	Naphthalene	A	0
31.	Nitric Acid, 20%	B	0
32.	Nitric Acid, 30%	B	0-2
33.	Nitric Acid, 70%	B	2-3
34.	Phenol, 90%	A	0-2
35.	Phosphoric Acid, 85%	B	0-1
36.	Silver Nitrate Saturated	B	0-1
37.	Sodium Hydroxide 10%	B	0-2
38.	Sodium Hydroxide 20%	B	0-2
39.	Sodium Hydroxide 40%	B	0-2
40.	Sodium Hydroxide Flake	B	0
41.	Sodium Sulfide Saturated	B	0
42.	Sulfuric Acid, 33%	B	0-1
43.	Sulfuric Acid, 77%	B	0-1
44.	Sulfuric Acid, 96%	B	1-3
45.	Sulfuric Acid 77% & Nitric Acid 70% equal parts	B	1-3
46.	Toluene	A	0
47.	Trichloroethylene	A	0
48.	Xylene	A	0
49.	Zinc Chloride, Saturated	B	0

2.12 METAL FABRICATIONS

- A. Applicability: This section applies to metal fabrications, including, but not limited to, pipe drop enclosures, shelving support systems, metal-framed laboratory tables, cylinder racks, and other miscellaneous brake-formed and shop fabricated components and trim.
- B. Manufacturers: Products complying with this specification may be provided by the following manufacturers, and/or other manufacturers that may be listed under individual products within this specification.
1. Kumar Industries, 4775 Chino Avenue, Chino, CA 91710 Tel: 909 591-0722.
 2. Karan and Associates, Inc., 13181 Santa Ana Ave., Fontana CA 92337 Tel: 909-967-1104.
 3. Approved substitution.
- C. Materials:
1. Steel: Cold-rolled furniture stock sheet steel, prime grade, roller leveled.
 - a. Steel shall be treated at the mill to be free of scale, ragged edges, deep scratches, or other injurious effects.
 - b. All gauges indicated are to be U.S. standard.

D. Finish Requirements:

1. Paint finish for steel laboratory products shall utilize a dry coating process with minimal waste generation. Liquid-applied coatings shall not be acceptable. Manufacturer shall supply documentation that waste generated during the painting process, is a solid, non-hazardous material.
 - a. Pretreatment: Finish process shall incorporate a phosphate conversion coating during the pretreatment/cleaning operation.
 - b. Operator Protection: The painting process shall be cleanly contained, have no solvent odor and be performed in an air-conditioned room.
 - c. VOC (Volatile Organic Compounds) emissions shall not exceed 0.29 pounds per gallon (35 g/L).
 - d. Offgasing: No further emissions or "Offgasing/Decomposition" vapors shall occur at room temperature from installed finished parts.
2. Preparation: After the units have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish to the metal and to aid in the prevention of corrosion. Physical and chemical cleaning of the metal shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a heated cleaner/phosphate solution and pretreated with iron phosphate spray followed by a neutral final seal prior to application of final finish. The strength of each solution shall be monitored by filtration to insure consistent quality. All treated parts shall be immediately dried in heated ovens and gradually cooled before application of the finish. Treated metal parts shall be clean and properly prepared to provide optimum adhesion of finish and resistance to corrosion.
3. Application: Electrostatically apply powder coat of selected color and bake in controlled high temperature oven to assure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:
 - a. All surfaces, exterior or interior, exposed to view, shall receive sufficient powder coat to achieve an average 1.5 mil (38 μ m) film thickness with a minimum 1.2 mil (30 μ m) film thickness and shall have smooth satin luster.
 - b. Backs of cabinets and other surfaces not exposed to view shall have sufficient powder coat to achieve an average 1.0 mil (25 μ m) film thickness.
4. All drawer bodies to be finished in matching color.
5. Concealed interior parts shall receive corrosion-resistant treatment.
6. Finish must be UV stable.
7. Color: As selected by the Architect.

E. Finish Performance Requirements:

1. Manufacturer shall submit metal finish performance testing results. Testing to be performed by independent testing agency.
2. Chemical Resistance:
 - a. Test procedure: Place samples on a flat surface, clean with soap and water and blot dry. Condition the panel for 48 hours at 73 +/- 3 degrees Fahrenheit (23(+ 2(C) and 50+ 5% relative humidity, or the currently accepted guideline set by ASTM. Test the samples for chemical resistance using forty-nine different chemical reagents by one of the following methods. For both methods, leave the reagents on the sample for a period of one hour. Wash off the sample with water, clean with detergent and naphtha, and rinse with deionized water. Dry with a towel and

evaluate after 24 hours at 73 +/- 3 degrees Fahrenheit (23± 2°C) and 50± 5% relative humidity, or the currently accepted guideline set by ASTM

- 1). Method A: Test volatile chemicals by placing a cotton ball saturated with reagent in the mouth of a 1 ounce (29.574cc) bottle and inverting the bottle on the surface of the sample. The cotton ball shall remain in contact with the sample for the duration of the test.
- 2). Method B: Test non-volatile chemicals by placing five drops of the reagent on the surface of the sample and covering with a 24mm watch glass, convex side down.

b. Rating System: Evaluations shall use the following rating system:

Level 0	No detectable change.
Level 1	Slight change in color or gloss.
Level 2	Slight surface etching or severe staining.
Level 3	Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

c. Acceptance Level:

- 1). Individual test results for the specified 49 reagents shall be within the Range for that reagent as specified on the table below.
- 2). There shall be no more than four (4) Level 3 conditions.

d. Table of reagents:

Test No.	Chemical Reagent	Test Method	Range
1.	Acetate, Amyl	A	0-1
2.	Acetate, Ethyl	A	0-2
3.	Acetic Acid, 98%	B	0-3
4.	Acetone	A	0-1
5.	Acid Dichromate, 5%	B	0-1
6.	Alcohol, Butyl	A	0-1
7.	Alcohol, Ethyl	A	0-1
8.	Alcohol, Methyl	A	0-1
9.	Ammonium Hydroxide, 28%	B	0
10.	Benzene	A	0-2
11.	Carbon Tetrachloride	A	0-1
12.	Chloroform	A	0-2
13.	Chromic Acid, 60%	B	0-2
14.	Cresol	A	0-2
15.	Dichloroacetic Acid	A	0-3
16.	Dimethylformamide	A	0-2
17.	Dioxane	A	0-2
18.	Ethyl Ether	A	0-1
19.	Formaldehyde, 37%	A	0-1
20.	Formic Acid, 90%	B	0-3
21.	Furfural	A	0-3
22.	Gasoline	A	0
23.	Hydrofluoric Acid, 37%	B	0-2
24.	Hydrofluoric Acid, 48%	B	0-3
25.	Hydrogen Peroxide, 30%	B	0-1
26.	Iodine, Tincture of	B	0-2
27.	Methyl Ethyl Ketone	A	0-2
28.	Methylene Chloride	A	0-2

Test No.	Chemical Reagent	Test Method	Range
29.	Monochlorobenzene	A	0-2
30.	Naphthalene	A	0-1
31.	Nitric Acid, 20%	B	0-1
32.	Nitric Acid, 30%	B	0-1
33.	Nitric Acid, 70%	B	0-3
34.	Phenol, 90%	A	0-2
35.	Phosphoric Acid, 85%	B	0-1
36.	Silver Nitrate Saturated	B	0
37.	Sodium Hydroxide 10%	B	0
38.	Sodium Hydroxide 20%	B	0
39.	Sodium Hydroxide 40%	B	0-1
40.	Sodium Hydroxide Flake	B	0
41.	Sodium Sulfide Saturated	B	0
42.	Sulfuric Acid, 33%	B	0
43.	Sulfuric Acid, 77%	B	0
44.	Sulfuric Acid, 96%	B	2-3
45.	Sulfuric Acid 77% & Nitric Acid 70% equal parts	B	1-3
46.	Toluene	A	0-1
47.	Trichloroethylene	A	0-1
48.	Xylene	A	0-1
49.	Zinc Chloride, Saturated	B	0

3. Hot Water Test

- a. Test Procedure: 190 to 205 degrees Fahrenheit (88°C to 96°C) hot water shall be allowed to trickle (with a steady stream and at a rate of not less than 6 ounces (177.5 cc) per minute) on the finished surface, which shall be set at an angle of 45 degrees Fahrenheit for a period of 5 minutes.
- b. Acceptance Level: After cooling and wiping dry, the finish shall show no visible effect from the hot water.

4. Paint Adhesion on Steel Test

- a. Test Procedure: Test shall be based on ASTM D2197-86 "Standard Method of Test for Adhesion of Organic Coating." Two sets of eleven parallel lines 1/16 inch (1.587 mm) apart shall be cut with a razor blade to intersect at right angles thus forming a grid to 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. Brush surface lightly with a soft brush for one minute. Examine under 100 fc (1076 lux) of illumination.
- b. Acceptance Level: Ninety or more of the squares shall show finish intact.

5. Impact Test

- a. Test Procedure: Drop a 1 pound (0.4536 kg) ball approximately 2 inches (50.8 mm) in diameter from a distance of 12 inches (305 mm), onto a flat horizontal surface, coated to manufacturer's standard manufacturing method.
- b. Acceptance Level: No visual evidence to the naked eye of cracks in the finish due to impact.

6. Paint Hardness on Steel Test

- a. Test Procedure: Paint film shall be tested with pencils of various hardnesses. Pencils shall have a wide, sharp edge. Pencils shall be pushed across surface in a chisel-like manner.

- b. Acceptance Level: Finish film shall not rupture from a sharpened 4H pencil.

2.13 STAINLESS STEEL FABRICATIONS

- A. Applicability: This section applies to stainless steel fabrications, including, but not limited to, work surfaces, sinks, stainless steel pipe drop enclosures, and other miscellaneous brake-formed and shop fabricated stainless steel components and trim as shown on the drawings.
- B. Manufacturers:
1. The Diamond Group, 895 Munch Street, Laval, Quebec H7S 1A9 Canada Tel: 450 668-0330.
 2. Inter Dyne Systems, Inc., 676 Ellis Road, Norton Shores, MI 49441 Tel: 231 799-8760.
 3. Kloppenberg & Co., 2627 West Oxford Avenue, Englewood, CO 80110 Tel: 303 761-1615.
 4. Approved substitution.
- C. Materials and Finishes:
1. Unless otherwise noted stainless steel shall be Type 304 and shall be of gauge indicated on Laboratory Furnishing drawings or this specification.
 2. All fabrications shall have exposed surfaces ground and polished to a No. 4 satin finish.
 3. All stainless steel nuts, screws, bolts, and rivets, etc., shall be of the same type stainless as in the sheet material and shall have a tumbled finish closely resembling that of a No. 4 finish.
 4. All stainless steel welding material shall be of type similar to the sheet material or a richer quality. All welds shall be made without discoloration and shall be ground, polished, and passivated to blend harmoniously with a No. 4 satin finish. All joints in stainless steel tops and work surfaces shall be welded.
- D. Work Surfaces:
1. Thickness: 16 gauge (1.6 mm).
 2. Fabrication:
 - a. Edges: Flanged down the same dimension as the adjacent non-stainless top, with 1 inch (25 mm) being a minimum and returned over a perimeter metal frame to simplify securing top material to cabinet or structural frame.
 - b. Reinforcement: Under-surface shall be reinforced with full length 16 gauge (1.6 mm) structural metal channels as required to insure rigidity and prevent buckling, warping, or oil canning. Where bench-mounted fittings are indicated on the drawings, provide top reinforcement to allow for rigid, secure mounting of fittings.
 - c. Undercoating: Underside of top shall have a heavy mastic agent coating providing sound deadening.
 - d. Stainless steel sides and backsplashes, where indicated, shall be integrally welded to top and finish as indicated above. The back side of exposed backsplashes shall be finished to match front and sides.
 - e. Provide all holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Verify size of opening with actual size of equipment to be used prior to making openings. Form inside corners to a radius of not less than 1/8 inch (3 mm). After sawing, rout and file cutouts to ensure smooth, crack-free edges with no burrs.
 3. Work surfaces with sinks: Work surfaces and sinks shall be integral, fabricated with a marine edge and shall be pitched to sink bowl for proper drainage. Marine edges shall be seamless die-formed.

4. Joints: Fabricate work surfaces in the largest sections practical for delivery to the job site. All joints shall be field-welded, ground smooth, and polished on-site to create a continuous work surface.
- E. Laboratory Sink: Integral one piece construction with stainless steel work surface.
1. Thickness: 18 gauge (1.3 mm thick), unless otherwise noted.
 2. Construction: Sink units shall be designed and fabricated with sufficient reinforcement to prevent oil canning. All sink joints shall be butt-welded, ground smooth by the heliarc welding process. Inside radii shall be 1 inch (25 mm). Bottoms shall be pitched to the drain indent. No soldering will be permitted in connection with sink construction. Sink bowl dimensions given are inside dimensions. Underside shall have a heavy mastic agent coating providing sound deadening.

2.14 SLOTTED CHANNEL FRAMING

- A. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
1. Unistrut, 35660 Clinton Street, Wayne, MI 48184 Tel: 800 521-7730.
 2. Cooper B-Line Inc. (B-Line), 509 West Monroe St., Highland, IL 62249 Tel: 618 654-2184.
 3. Kumar Industries (Nu-Strut), 4881 Chino Ave., Chino, CA 91710 Tel: 909 591-0722.
 4. Power Engineering Co. (Powerstrut), 420 Boston Turnpike, Shrewsbury, MA Tel: 800 274-1303.
 5. Wesanco, Inc. (Westrut), 14870 Desman Road, La Mirada, CA 90638 Tel: (714)-739-4989.
 6. Approved substitution.
- B. Materials: Channel and framing members shall be fabricated from steel conforming to the following requirements:
1. Framing Members:
 - a. Concealed Framing Members and Fittings: ASTM A570 GR 33.
 - b. Exposed Framing Members and Fittings: ASTM A446 GR A with zinc coating conforming to ASTM A525.
 - c. Stainless Steel Framing Members and Fittings: ASTM A240 (Type 304), where indicated.
 2. Fittings:
 - a. Concealed Fittings: Fabricate from steel satisfying the requirements of ASTM A570 GR 33, and conform to the following ASTM specifications: A575, A576, A36, or A635. Nuts shall conform to ASTM A576 GR 1015 and screws shall conform to SAE J429 GR 2 and ASTM A307.
 - b. Exposed Fittings: Fabricate from steel satisfying the requirements of ASTM A570 GR 33, and conform to the following ASTM specifications: A575, A576, A36, or A635. Nuts shall conform to ASTM A576 GR 1015 and screws shall conform to SAE J429 GR 2 and ASTM A307. Exposed fittings shall receive zinc coating conforming to ASTM A525.
 - c. Stainless Steel Fittings and Hardware: Sintered Nuts shall be of ASTM B783 (Type 316N2-33) stainless steel and fittings shall be of ASTM A240 (Type 304) stainless steel. Stainless steel fittings and hardware shall be used with stainless steel framing members, or where indicated.

3. Thickness: 12 gauge, unless noted otherwise.
4. Size: 1 5/8 inch by 1 5/8 inch cross-section, unless noted otherwise.

C. Components:

1. The following components shall be provided, unless otherwise noted:
 - a. Framing Channel: 1 5/8 inch by 1 5/8 inch by 12 gauge: Unistrut P1000, Powerstrut PS 200, Kumar Industries N-200, B-Line Systems, Inc. B22, or equal.
 - b. Suspended Framing Channel, 3 1/4 inch by 1 5/8 inch by 12 gauge: Unistrut P5000, Powerstrut PS 100, Kumar Industries N-150, B-Line Systems, Inc. B11, or equal.
 - c. 90° Angle Fitting: 4 1/8 inch by 3 1/2 inch by 1/4 inch with two holes, each leg: Unistrut P1325, Powerstrut PS 607, Kumar Industries N-1123, B-Line Systems, Inc. B104, or equal.
 - d. 135° Angle Fitting: 3 inch by 2 5/16 inch by 1/4 inch with one hole, each leg: Unistrut P1546, Powerstrut PS 633-45°, Kumar Industries N-1425, B-Line Systems, Inc. B154, or equal.
 - e. T-Shaped Flat Plate Fitting: 5 3/8 inch by 3 1/2 inch by 1/4 inch plate, T-shaped, with four holes: Unistrut P1031, Powerstrut PS 714, Kumar Industries N-1022, B-Line Systems, Inc. B133, or equal.
 - f. Wing Shape Fitting, 9 5/32 inch by 3 7/8 inch ten holes, two holes in each wing section and two holes in each of three channel section sides: Unistrut P2347, Powerstrut PS 913, B-Line Systems, Inc. B273.
 - g. Vertical Posts: 3 1/4 inch by 1 5/8 inch by 12 gauge, double channel section: Unistrut P1001, Powerstrut PS 200 2T3, Kumar Industries N-200-A, B-Line Systems, Inc. B22A, or equal.
 - h. Horizontal Support Members: 1 5/8 inch by 1 5/8 inch by 12 gauge framing channel with 13/32 inch by 3 inch slotted holes, 4 inches on center: Unistrut P1000 SL, Powerstrut P 200 S, Kumar Industries N-200-SL, B-Line Systems, Inc. B22S, or equal.
 - i. Slotted Hole Framing Channel, 1 5/8 inch by 1 5/8 inch by 12 gauge framing channel with 13/32 inch by 3 inch slotted holes, 4 inches on center: Unistrut P1000 SL, Powerstrut P 200 S, Kumar Industries N-200-SL, B-Line Systems, Inc. B22S.
 - j. Slotted Framing Channel for installation in Chemical Fume Hoods, 1 5/8 inch by 13/16 inch by 16 gauge Type 316 stainless steel framing channel: Unistrut P4000 SS, Powerstrut PS 560 SS, Kumar Industries, B-Line Systems, Inc.
 - 1). Attach channel to side of fume hood with 2 5/8 inch by 1 7/8 inch by 1/8 inch, 4 hole, stainless steel 90° fitting: Unistrut P6325 SS, Powerstrut, Kumar Industries, B-Line Systems, Inc.
 - k. Diagonal Brace Supports: Framing Channel, 1 5/8 inch by 1 5/8 inch by 12 gauge: Unistrut P1000, Powerstrut PS 200, Kumar Industries N-200, B-Line Systems, Inc. B22, or equal.
 - l. Closure Strip: 0.04 inches thick snap-in cover for framing channel: Unistrut P3184, Powerstrut PS 6152, Kumar Industries N-1920, B-Line Systems, Inc. B217-24, or equal. Provide closure strips over all exposed vertical post sections.
 - m. End Caps: 0.06 inches thick for framing channel: Unistrut P1280, Powerstrut PS 707, Kumar Industries N-2500, B-Line Systems, Inc. B205, or equal. Provide end caps for all exposed horizontal framing channels.
 - n. Ceiling Escutcheon: Provide 18 gauge steel, finished to match framing members, as indicated on the Laboratory Furnishing drawings, at ceiling penetrations.
 - o. Other components, hardware, and fasteners, as required for a complete assembly and as indicated on the drawings.

2. Service Struts and Ledging:
 - a. 16 gauge, 13/16 inch by 1 5/8 inch cold-formed framing uprights: Unistrut P4000, Powerstrut PS 560, Kumar Industries N-400, B-Line Systems, Inc. B56, or equal. Uprights shall be provided at 48 inches, maximum, and fastened top and bottom by two adjustable U-shaped spreaders.
 - b. U-shaped spreaders: 12 gauge by 1½ inch (45 mm) wide by length required, galvanized steel.
 - c. Locations:
 - 1). Provide to support tops at pipe service chase space, support drain troughs, under fume hood superstructures, and other abnormal loads.
 - 2). Support struts with U-shaped spreaders shall be provided at 48 inches (1220 mm) on center below island and peninsula benches, as indicated on drawings. Support struts shall be provided along wall 48 inches (1220 mm) on center below island and peninsula benches. Struts will be used to support piped and electrical services installed under Divisions 22, 26, and 27. Provide all bolts, expansion sleeves, and fastening devices for a complete assembly. Pipe and conduit hangers shall be provided by Division 22, 26, and 27 installers.
3. Cylinder and Dewar Restraint:
 - a. Swivel Hanger: 1 ¾ inch long by 3/8 inch diameter link welded to threaded stud; provide two per cylinder: Unistrut M2350, Powerstrut PS205, Kumar N-2911, B-Line 446B.
4. Finish:
 - a. Provide finish coating for all cold-formed framing components, except for stainless steel components.
 - b. Concealed Framing Members and Fittings: Rust inhibiting acrylic enamel paint applied by electrostatic deposition, after cleaning and phosphating, and thoroughly baked. Finish shall withstand a minimum of 400 hours salt spray when tested in accordance with ASTM B117. Color: Green.
 - c. Exposed Framing Members and Fittings: Factory applied epoxy powder coat. Color: To be selected by the Architect.

2.15 SEALANT

- A. Manufacturers: Products complying with this specification may be provided by the following manufacturers.
 1. Dow Corning Corporation, P.O. Box 994, Midland, MI 48686 Tel: 989 496-7881.
 2. General Electric Company, 260 Hudson River Rd., Waterford, NY 12188 Tel: 800 255-8886.
 3. C.R. Laurence Company, Inc., 600 Wharton Drive, Atlanta, GA 30336 Tel: 404 696-3445
 4. Approved substitution.
- B. Basis of Design: Dow Corning 732 Multi-Purpose Sealant, GE Silicones RTV 100 Series, C.R. Laurence CRL 33S Silicone, or equal.
- C. Characteristics:
 1. Type: One-part silicone rubber, MIL-A-46106.
 2. Physical form: Non-slumping paste.

3. Cure: Cures at room temperature on exposure to water vapor in the air.
4. Authorizations:
 - a. FDA Regulation No. 21 CFR 177.2600.
 - b. USDA Rating P1.
 - c. NSF Rating C2.
 - d. UL 150 C Rating, File No. E40195 (N).
5. Properties:
 - a. Tack Free Time, ASTM C-679: 45 minutes, maximum.
 - b. Durometer, Shore A Hardness, ASTM D-2240: 20, minimum.
 - c. Tensile Strength, ASTM D-412: 220 pounds per square inch, minimum.
 - d. Elongation, ASTM D-412: 350 percent, minimum.
 - e. UV Resistance, ASTM C-793: Excellent.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

A. Inspection:

1. Prior to installation of the work of this Section, carefully inspect the installed work specified in other Sections and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that all work may be installed in complete accordance with the original design, reviewed submittals, and the manufacturer's recommendations.
3. Where floor conditions require shimming or leveling of more than $\frac{3}{4}$ inch at any point, do not install casework in those locations. Notify the contractor and design team that remedial measures will be required to bring the floors closer to a level situation.

B. Discrepancy: In the event of discrepancy, immediately notify the Architect.

3.2 INSTALLATION

A. Coordinate work with any Owner furnished and/or installed components indicated on drawings.

B. General: Assemble units into one integral unit with joints flush, tight, and uniform. Align similar adjoining units to a tolerance of 1/16 inch (1.5 mm).

C. Cabinets:

1. Install cabinets to create a plumb, level, true and straight installation.
2. Installation of metal casework fixed cabinets shall utilize the internal leveling devices. Do not use shims.
3. Installation of wood casework shall be performed using shims. Shimming shall be minimized as much as possible, yet be sufficient to achieve a level and plumb condition.
4. Installation shall maintain the required height of countertops, but in all cases must stay within the range required by the ADA regulations.
5. Securely fasten wall units to solid supporting material, not plaster, lath, or wallboard. Anchor, adjust, and align wall cabinets as specified for base cabinets. Verify that all required backing and reinforcement necessary to support wall-mounted units is in place, secure, and accurately located.

D. Installation materials:

1. Installation of wood casework may involve the use of shims, spacers, cleats, straps and other such items of either metal or wood composition.
2. Installation of metal casework shall use spacers, cleats, and straps of galvanized steel, epoxy-coated steel, or stainless steel. No wood materials of any sort shall be part of the permanent installation of metal casework.
3. Installation of stainless steel counters shall use spacers, cleats, and straps of stainless steel of the stainless steel type specified for the casework construction. No wood or carbon steel materials of any sort shall be part of the permanent installation of stainless steel casework.

E. Laboratory Tops:

1. Scribe tops as necessary for close and accurate fit. Joints between worksurfaces, backsplashes, and adjacent items, penetrations, or similar shall be hairline joints, with a maximum width of 1/16 inch.
2. Field Joints: Factory-prepared and identical to factory joints, locate only where indicated on approved Shop Drawings. Field processing of top and edge surfaces is not acceptable, except as described by manufacturer in approved Submittal Data. Provide full length, one-piece tops and backsplashes wherever possible, and keep field joints to an absolute minimum.
3. Abut top and edge surface in one true plane, with internal supports placed to prevent any deflection. Joints in top units shall be flush and the narrowest for the respective materials of construction. Cement top joints and laboratory sinks in accordance with the manufacturers' specifications.
4. All joints in stainless steel work surfaces shall be field-welded, ground smooth, and polished on site to create a continuous work surface. All grinding marks must be removed so finish is completely consistent.

F. Sealant:

1. Caulk edges of tops, backsplashes and side splashes to adjacent wall surface, tall casework, and fume hood with silicone sealant.

3.3 DESTRUCTIVE TESTING

- A. The Owner, Architect, and/or Contractor may, at their own cost, elect to perform destructive testing on casework cabinet components (such as fronts, sides, etc.) to confirm compliance with the requirements of this specification. The casework manufacturer/installer should account for the de-installation, repair, and reinstallation, or replacement of one cabinet that may be selected for destructive testing.

3.4 CLEANING AND PROTECTION

- A. Repair or remove and replace defective work as approved by the Architect at no additional cost to the Owner.
- B. Clean finished units, touch up as required, and remove and refinish damaged or soiled areas.
- C. Cover tops with kraft paper or polyethylene sheeting and all other means necessary after installation for protection against scratching, soiling, and deterioration during remainder of construction period. Remove protection prior to final cleaning.
- D. Clean counter tops with diluted dishwashing liquid and water leaving tops free of all grease and streaks. Use no wax or oils.

END OF SECTION 115310

SECTION 115313 - FUME HOODS AND OTHER AIR CONTAINMENT UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Chemical Fume Hoods, including bench mounted hoods and full-view hoods
- B. Fume Extractor Arms (Snorkels)

1.2 RELATED SECTIONS

- A. Section 115310: Laboratory Casework and Other Furnishings
- B. Section 115343: Laboratory Service Fittings and Fixtures
- C. Division 22: Plumbing
- D. Division 23: Heating, Ventilating, and Air Conditioning (HVAC)
- E. Division 26: Electrical

1.3 REFERENCES

- A. Chemical fume hoods:
 - 1. ASHRAE 110, Method of Testing Performance of Fume Hoods.
 - 2. Conform to the recommended practices for laboratory fume hoods published by the Scientific Equipment and Furniture Association: SEFA 1 Recommended Practices for Fume Hoods.

1.4 DESCRIPTION

- A. Provide equipment complete with accessories as described herein and shown on Laboratory Furnishings drawings.
- B. Chemical fume hoods:
 - 1. Fume hoods with accessories shall be pre-piped and pre-wired. Pre-pipe service fittings to single point connection at 6 inches (150 mm) above top of hood or as otherwise shown.
 - a. Refer to Section 115343 and details on Laboratory Furnishings drawings for service fittings.
 - b. P-trap, waste piping and tailpiece extensions for cupsinks shall be furnished and installed by Division 22. Comply with Division 22 requirements for piping and installation requirements for respective pre-piped services.
 - c. Pre-wire all electrical devices to junction box at top of hood. Comply with Division 26 requirements for electrical work.
 - d. Piping at full-view fume hoods shall be pre-piped for continuation from the bottom of the fume hood to the service valves.

1.5 SUBMITTALS

- A. Refer to the General Conditions and Division 1 "Submittal Procedures" for submittal requirements. In addition to these requirements, provide submittal requirements specified herein.

- B. Submittal requirements:
1. Submittal shall be prepared individually for this specification section. Arrange product data, drawings and information for submission in a complete set for this specification section.
 2. Submittal shall contain complete data for all items of this specification section. Periodic or partial submittals of individual components within this specification section will be returned as incomplete and rejected.
 3. Submittals shall be organized by specification sequence with section and paragraph number identified.
 4. Equipment and components being proposed shall be clearly labeled with all options and accessories indicated and shall be for this specific project. All non-applicable options, items and components shall be deleted or struck.
- C. Materials List/Product Data: Submit complete materials list, including catalog data of all materials, equipment, and products for Work specified in this Section. Include chemical resistance finish performance test results for any products specified in this section.
- D. Shop Drawings: Submit complete shop fabrication and installation drawings, including plans, elevations, sections, details and schedules. Show relationship to adjoining materials and construction. Shop Drawings shall be in the form of reproducible or photocopies, not to exceed 11 inches by 17 inches (A3) in size. Blue line prints are not acceptable.
- E. Approved Substitution/Approved Equal: In addition to the items required in Division 1, all substitution requests shall include item-by-item comparison of the proposed substitution to this project specification. A copy of the project specification shall be submitted, with each item and subsection of the project specification marked as "Comply" or "Not Comply." In any cases where "Not Comply" is indicated, an explanation of the relative advantages of the proposed design shall be provided.
1. Substitution shall not affect dimensions shown on Drawings.
 2. The Contractor shall pay for changes to the building design, including engineering design, detailing, utility and service requirements, and construction costs caused by the requested substitution.
 3. Substitutions shall have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
 4. Maintenance and service parts shall be locally available for the proposed substitution.
- F. Submit detailed anchorage and attachment detail drawings for seismic restraint.
- G. Samples: Submit two (2) samples of each type of specified finish and color range available.
- H. Test Reports: Submit the following performance test reports.
1. "As Manufactured" (AM) Fume Hood Testing in Manufacturing Facility: Provide certification that each type and size of fume hood has passed Flow Visualization and Face Velocity tests, and achieved an AM performance rating equal or better than 0.05 ppm with 4.0 Lpm tracer gas release rate when tested in accordance with ASHRAE 110-2016.
 2. Fume Hood Sound Level Certification: Provide certification of fume hood compliance with design criteria for maximum allowable noise within laboratories.
 - a. At project design operating conditions for sash height and face velocity, test data of octave band analysis verifying hood is capable of a 50 NC or lower value when connected to a 50 NC (minimum) HVAC source. Measurements shall be taken 36 inches (915 mm) in front of open sash.

3. Fume Hood Certification: Submit "As Installed" (AI) test report as described elsewhere in this section.
- I. Operations/Maintenance Manuals: At project close-out, submit for Architect's review and Owner's use, complete operating and maintenance manuals that describe proper operating procedures, maintenance and replacement schedules, component parts list, and closest factory representative for components and service.
 1. Maintenance Materials: Furnish additional materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Furnish as follows:
 - a. Light Fixtures: 10% of each type and rating installed and no fewer than one of each type and rating installed.

1.6 QUALIFICATIONS

- A. Work in this Section shall be performed by a firm having a minimum eight years documented experience, and an established organization and production facilities including all tools, equipment and special machinery necessary for specializing in the fabrication and installation of the type of equipment required with skilled personnel, factory trained workmen and an experienced engineering department. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.

1.7 COORDINATION

- A. Work of this Section requires close coordination with Work of Divisions 22, 23 and 26 as well as Work specified in other Sections. Sequence all Work to ensure an orderly progress in the project without removal of previously installed Work and so as to prevent damage to finishes and products.
- B. Coordinate, furnish, and install chemical fume hoods designed for variable air volume (VAV) or constant air volume (CAV) operation as indicated in the mechanical drawings. The designed exhaust airflow control method (VAV or CAV) shall be confirmed and coordinated prior to submission and shall be clearly indicated in the submittal product documentation.

1.8 WARRANTY

- A. Refer to the General Conditions and Division 1 "Product Requirements" for warranty requirements. In addition to these requirements, all products shall be warranted to be free from defects in materials and workmanship for a minimum period of one year following substantial completion. The manufacturer/ dealer/ subcontractor shall repair or replace any products (or parts thereof) that are found to be defective. Replacement will include any parts, labor, shipping, and travel expenses involved. Warranty replacement work must be scheduled in coordination with the Owner's academic/research schedule, and may therefore require evening and/or weekend work.

PART 2 - PRODUCTS

2.1 ACCESSIBILITY FOR PERSONS WITH DISABILITIES

- A. Where indicated on Laboratory Furnishings drawings, fume hoods shall be furnished and installed in a manner to make them accessible to persons with disabilities in accordance with the Americans with Disabilities Act and any state or local building code or regulation having jurisdiction. The height of the highest point of access to the work surface above finished floor

shall not exceed 34 inches. Sash operation, fittings for piped services and electrical receptacles, and other controls shall be of a design and in a location in order to be considered accessible.

2.2 CHEMICAL FUME HOODS

- A. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.
1. Air Master Systems Corporation, 6480 Norton Center Drive, Muskegon, MI 49441 Tel: 231 798-1111.
 2. Bedcolab Ltd, 2305 Francis Hughes Avenue, Laval, Quebec, Canada H7S 1H5 Tel 514 384-2820.
 3. ICIscientific, 1865 Highway 641 North, Paris, TN 38242-8814 Tel: 731-642-4251.
 4. Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
 5. Labconco Corporation, 8811 Prospect Avenue, Kansas City, MO 64132 Tel: 800 821-5525.
 6. Mott Manufacturing Limited, 452 Hardy Road, P. O. Box 1120, Brantford, ON, Canada N3T 5T3 Tel: 519 752-7825.
 7. Approved substitution.
- B. Underwriters Laboratory Listing: Fume hoods shall be UL subject 1805 classified. Label shall be attached to the face of each fume hood indicating classification to the UL 1805 standard for Laboratory Fume Hoods.
- C. Materials: The following materials shall be provided, unless superseded by the requirements listed below for specific fume hood types.
1. Steel:
 - a. ASTM A366 mild steel, furniture stock, cold-rolled, pickled, double annealed, and free from rust, scale, scratches, buckles, ragged edges, and other defects.
 - b. Minimum Thickness: 18 gauge (1.2 mm).
 2. Stainless Steel:
 - a. Type 316, ASTM 240, with exposed surfaces ground and polished to a No. 4 finish.
 - b. Minimum Thickness: 16 gauge (1.6 mm).
 - c. Welding: All stainless steel welding material shall be of similar type to sheet material. Welds shall be made without discoloration, ground, polished, and passivated to blend with a No. 4 finish.
 3. Liner and Baffle:
 - a. Typical: Glass-reinforced polyester panel, flame-retardant and self-extinguishing with smooth finish and white color. Flexural strength: 14,000 psi. Flame spread index of 0-25 when tested per UL 723 and ASTM E 84. Baffle shall be same material as liner. Liner thickness: 3/16 inch (4.76 mm); baffle thickness: ¼ inch (6.35 mm), minimum. Liner performance characteristics shall be as specified below.
 4. Glass: 7/32 inch (5.56 mm) laminated safety glass. Glass shall not be etched with manufacturer's name, logo, or any other permanent markings, other than to identify the glass as safety glass. Light fixture lens may be tempered safety glass.
 5. Sash guides: Extruded PVC.

6. Sash cable (allowed for full-view hoods only): Uncoated, 1/8 inch (3.18 mm), stainless steel cable; Military Spec ML-WW-834420D-3.
 - a. Pulley assembly for sash cable: 2 inch (50.80 mm) diameter, zinc dichromate finish, ball bearing type, with cable retaining device. Nylon tire is not acceptable.
7. Sash chain: ANSI #35 steel, single strand. Average tensile strength of 2,400 pounds; maximum working load of 480 pounds.
 - a. Pulley assembly for sash chain: Finish bored steel drive sprockets and keyed drive, 1/2-inch (12.7 mm) diameter front connector shaft. Rear idler sprockets; double sealed ball bearings type, lubricated. All sprockets steel with zinc dichromate finish.
8. Sash belt: Two 1/2 inch wide stainless steel-reinforced polyurethane notched belts. Minimum tension cord strength of 840 N.
 - a. Pulley assembly for sash belt: Cast aluminum sprocket mated to a steel shaft.
9. Sash pull material shall be one of the following, and the pull shall be the full width of the hood sash.
 - a. Steel with chemical resistant powder coating.
 - b. Stainless steel.
10. Gaskets: Provide PVC gasket at interior access panels to eliminate air leakage and retain liquids inside hood.
11. Fasteners:
 - a. Exterior structural member attachments: Sheet metal screws, zinc plated.
 - b. Interior fastening devices shall be concealed; exposed screws are not acceptable. Screw head caps are not acceptable.
 - c. Exposed exterior fastening devices shall be corrosion-resistant, non-metallic material; exposed screws are not acceptable.

D. Construction:

1. Design: Fume hoods shall be designed for consistent and safe air flow through the hood face opening. Variations of face velocity shall not exceed $\pm 20\%$ of the average face velocity at any designated measuring point.
 - a. Refer to the Laboratory Equipment Exhaust Schedule on the Laboratory Furnishings drawings for the design face velocity requirements for each type of fume hood.
2. Superstructure: Rigid, self-supporting assembly of double wall construction, maximum 4 7/8 inch (124 mm) thick. Wall shall consist of a sheet steel outer shell and a corrosion resistant inner liner, and shall house and conceal steel framing members, attaching brackets and remote operating service fixture mechanisms and services. Panels shall be attached to a full frame construction, minimum 14 gauge (2.0 mm) galvanized members. Panels and brackets attached to eliminate screw heads and metallic bracketry from hood interior.
3. Sash Design: All fume hood sashes (vertical and horizontal) shall be designed to require no more than 5 pounds of force to operate the sash throughout full range of the sash opening.

4. Access Panel: Access to fixture valves and piping concealed in wall shall be through flush access panels on the inside liner walls, or through removable front posts. Panels shall be secured with PVC extruded gasket, or tamperproof, epoxy-coated, countersunk flat head screws providing a tight fit. Hook and loop type attachments and panels held by gravity are not acceptable.
5. Downdraft bypass: Low resistant type, 18 gauge (1.27 mm) steel chamber; directional louvers are not acceptable. All bypass air shall enter top of bypass chamber and enter hood in a downflow direction. Chamber shall protect user from expelled particulate in the event of an adverse internal reaction.
 - a. Provide 18 gauge steel paneled enclosure from top of hood to 2 inches above the ceiling.
6. Trim and Side Panels: Provide matching steel trim and side panels, as required, to finish any openings around and between hoods. Panels shall be flush with other hood panels, and finish shall match superstructure exterior. At locations where fume hoods are back-to-back, provide one of the following:
7. Finished Back: Provide for any fume hood where back of hood is exposed to view. 18 gauge steel sheet. Finish shall match superstructure exterior.
8. Bypass Grille: Low-resistant type 18 gauge steel with upward directional louvers.
9. Exhaust Duct Collar:
 - a. Construction: Provide Type 316L stainless steel, minimum 18-gauge, duct collar with 1 ½ inch (38 mm) to 2 inch (50 mm) extension above top of fume hood with butt joint termination suitable for welding. Duct collar design shall be bell-mouthed for round or contoured design for rectangular to provide lower static pressure drop and improved noise performance. Duct collar shall be integral to fume hood construction, factory-installed, and welded or permanently sealed airtight to hood.
 - b. Configuration: For collar size and quantity, refer to Laboratory Equipment Exhaust Schedule on the Laboratory Furnishing drawings.
10. Exhaust Duct Transition Piece: Furnished by the fume hood manufacturer for installation by the mechanical contractor. Provide contoured Type 304 stainless steel, minimum 18 gauge, exhaust duct transition piece to connect to the fume hood exhaust duct collar and Laboratory exhaust duct system as shown on the Mechanical Drawings. Provide butt joint terminations suitable for welding. Note: Transition Piece is not required where hood exhaust duct collar has been provided per the Laboratory Equipment Exhaust Schedule.
11. Cup Sink:
 - a. Oval with raised rim, material and color to match work surface, sizes in accordance with drawings. Comply with Section 115343 requirements.
 - b. Raised Rim Height: ¼ inch (6.35 mm).
12. Piping shall be as specified in Division 22 for respective system.
13. Service Fittings: As shown on Laboratory Furnishings Drawings and specified in Section 115343, factory-installed and complete with all gaskets, grommets and sleeves. No additional holes in fume hood side posts shall be provided for services beyond those required by the construction documents.
14. Alarm: Coordinate cut out for fume hood alarm to be provided under Division 23. All cut outs for alarm shall be made in the factory; field cutting is not acceptable.
 - a. Locate at 48 inches or below for all Accessible designated fume hoods.
15. Electrical:

- a. Pre-Wiring: All fume hood electrical devices shall be factory-installed and wired to a junction box located on top of the hood. Comply with Division 26 requirements for electrical work.
 - 1). Fume hood receptacles shall be wired such that no more than two duplex outlets and the hood lighting are wired through a single circuit.
 - b. Receptacles: Flush mounted, 125V / 20A / 60Hz duplex type, single gang, NEMA 5-20R, 3-wire, grounding type receptacle, one or two per side, or as indicated on the Laboratory Furnishings Drawings, with brushed stainless steel cover plate. Each side of the fume hood shall have a GFCI receptacle with feed-through protection of any downstream receptacles.
16. Interior Hood Lighting:
- a. Lighting within the hood shall be provided by a UL approved, vapor-proof, LED light fixture operated by an exterior switch with a stainless steel cover plate. LED light color shall be from 3000 to 3500 Kelvin. Light fixture shall be approved for recessed and enclosed spaces, and third-party tested to 50,000 hours.
 - b. Provide 1/4 inch thick safety glass panel cemented and sealed to the hood roof.
 - c. Light level: Average light level on the work surface shall be 80 foot-candles, minimum.
17. Safety label: Provide self-adhesive polyester label, as detailed on the Laboratory Furnishing drawings. Label shall indicate safe operating conditions with respect to fume hood sash position. Labels solely indicating 100 fpm face velocity sash position are unacceptable.
18. Hood Finish: As specified elsewhere in this Section.
19. Exterior Color: As selected by Architect from manufacturer's full color line and complying with finish requirements.
20. Camera: Provide Ken-A-Vision model Video Flex 5400 Fume Hood Camera, or approved substitution. Holes shall be pre-drilled by the fume hood manufacturer, and minimized to prevent leakage. Camera shall be installed in the field on the side of the fume hood interior. Route camera USB cable inside the fume hood post to the top of the fume hood and connect to data/USB connection. Provide gasket or seal at all penetrations. Refer to Laboratory Furnishings drawings for fume hoods with cameras.
- E. Bench Mounted Chemical Fume Hoods:
1. Style: General purpose.
 - a. Subject to compliance with the requirements listed below, acceptable models include:
 - 1). Solution Series Fume Hoods by Air Master Systems Corporation.
 - 2). Vanguard Fume Hood by BedcoLab Ltd.
 - 3). Isolator Bench Fume Hood by ICI Scientific Metal Products, Inc.
 - 4). Supreme Air Venturi Fume Hood by Kewaunee Scientific Corporation.
 - 5). Protector XL Benchtop Laboratory Hood by Labconco Corporation.
 - 6). Pro Restricted Bypass Bench Fume Hood by Mott Manufacturing Limited.
 2. Exterior depth: 34 1/2 inches, maximum.
 3. Interior depth: 23 1/2 inches clear at 1 inch above the work surface, minimum.
 4. Design:

- a. Restricted bypass fume hoods for variable air volume or constant volume exhaust systems with airfoil. Bypass shall be sufficient in size to allow 25% flow with sash closed. Bypass must be achieved through low resistance opening at top of front lintel panel. Bypass shall be designed to provide a smooth down flow effect.
 - b. Fume hoods shall be designed to operate safely at face velocities of 100 feet per minute (0.51 m/s) to 125 feet per minute (0.64 m/s).
5. Work Surface: 1 ¼ inch (32 mm) dished epoxy resin, in compliance with Section 115310 requirements. Color: Black.
6. Airfoil: The airfoil shall allow ample room for electrical hospital grade cords to fit beneath the airfoil. Sill must pivot forward to provide cord and trough access. Bottom horizontal foil shall provide nominal 1 inch (25.4 mm) bypass when sash is in the closed position. Bottom foil shall not be removable without use of special tools. Airfoil shall be steel with urethane or epoxy powder coating.
- a. Sill shall be rounded or chamfered on front edge with all right angle corners radiused or angled. The air foil and sill shall be flush with the height of the work surface; airfoil sills that are not flush with the top plane of the work surface dish are not acceptable.
7. Fume hood sash (Vertical): Full-view, frameless type with clear, unobstructed, side-to-side view of fume hood interior and service fixture connections. Sash to have a 35 inch (890 mm), nominal, sight line.
- a. Sash Opening: Refer to the Laboratory Equipment Exhaust Schedule on the Laboratory Furnishings drawings for vertical access height clearance.
 - b. Split Sashes: Refer to the Laboratory Equipment Exhaust Schedule on the Laboratory Furnishings drawings for the quantity of vertical rising sashes. At fume hoods where 2 vertical sashes are indicated, provide a sash guide that retracts when both sashes are raised. A fixed post between sashes is not acceptable.
8. Fume hood sash (Combination horizontal/vertical - only where indicated): Provide vertical and horizontal sash access with a 35 inch (890 mm), nominal, high sight line. Sash shall be top hung on nylon tired stainless steel ball bearing wheels. Sash frame on bottom and sides must be no more than 1 ½ inch (38 mm) thick and radiused to minimize turbulence. Area above the vertical sash opening shall be glazed with a minimum of 3/8 inch (9.53 mm) thick laminated safety glass. All glass to have polished exposed edge treatment. Horizontal panels provided with finger pulls.
- a. Sash Opening: Refer to the Laboratory Equipment Exhaust Schedule on the Laboratory Furnishings drawings for vertical access height clearance.
 - b. Counterbalance system: Single weight, counterbalance system to prevent sash tilting and permit ease of operation at any point along full width pull. Design system to hold sash at any position without creep and to prevent sash drop in the event of suspension system failure.
 - c. Sash Opening: Refer to the Exhaust Equipment Schedule on the Laboratory Furnishings drawings for vertical access height clearance.
 - d. Sash Stop: Design to stop the sash at the Design Operating Condition as shown on the Exhaust Equipment Schedule, with manual override.
 - 1). Sash stop must be easy to operate, not requirement excessive force.
 - 2). Provide one of the following types of sash stops for all fume hoods:
 - a). Corrosion-resistant, spring-loaded lever handle integrated with sash track and fume hood side post.

- b). Stainless steel spring-loaded barrel-bolt integrated with sash pull and provided with angled stainless steel strike plate.
 - 9. Baffle screen: Provide a perforated stainless steel screen or mesh designed to block debris and light materials from going up behind the baffle and into the exhaust ductwork.
- F. Full-View Chemical Fume Hoods:
- 1. Style: Full-view. Superstructure shall be glazed on all sides to provide maximum visibility from the surrounding area.
 - a. Subject to compliance with the requirements listed below, acceptable models include:
 - 1). TruView Fume Hood by Kewaunee Scientific Corporation.
 - 2). Protector ClassMate Laboratory Hood by Labconco Corporation.
 - 3). Observation Bench Fume Hood by Mott Manufacturing Limited.
 - 2. Exterior Depth, Single-Sided: 32-1/4 inches (820 mm), nominal.
 - 3. Exterior Depth, Double-Sided: 64-5/8 inches (1641 mm), nominal.
 - 4. Overall Height: 60 inches, nominal for hood superstructure. No part of the fume hood shall extend above 96 inches above finished floor.
 - 5. Design:
 - a. Restricted bypass fume hoods for variable air volume or constant volume exhaust systems with airfoil. Bypass shall be sufficient in size to allow 25% flow with sash closed. Bypass must be achieved through low resistance opening at top of front lintel panel. Bypass shall be designed to provide a smooth down flow effect.
 - b. Design fume hoods for consistent and safe air flow through the hood face. Negative variations of face velocity shall not exceed 20% of the average face velocity at any designated measuring point as defined in this section.
 - 1). Fume hoods shall be designed to operate safely at face velocities of 100 feet per minute (0.51 m/s) to 125 feet per minute (0.64 m/s).
 - c. Lower 34 inches (863 mm) of hood above the work surface shall be a minimum of 75 percent clear glass to maximize sightline.
 - d. Hood design shall incorporate the sash and front face of hood to be canted at an angle of 5 to 10 degrees away from the user.
 - e. Workstation shall be single-sided or double-sided, as indicated on the drawings. Base cabinets shall be as indicated on the drawings and specified in Section 115310.
 - f. Design double-sided fume hood workstations with exhaust separation for individual exhaust on each side of the workstation. Provide each side with an independent fume exhaust collar for connection to the mechanical fume exhaust systems. The exhaust air system for each side of the workstation shall operate independently.
 - 6. Glazing Gaskets: PVC extrusion.
 - 7. Work Surface: 1 ¼ inch (32 mm) dished epoxy resin, in compliance with Section 115310 requirements. Color: Black.
 - 8. Airfoil: The airfoil shall allow ample room for electrical hospital grade cords to fit beneath the airfoil. Sill must pivot forward to provide cord and trough access. Bottom horizontal foil shall provide nominal 1 inch (25.4 mm) bypass when sash is in the closed position. Bottom foil shall not be removable without use of special tools. Airfoil shall be steel with urethane or epoxy powder coating.

- a. Sill shall consist of a half-round bullnose on front edge. Air foil and sill to be flush with the height of the work surface; airfoil sills that are not flush with the top plane of the work surface dish are not acceptable. A secondary containment trough shall be located in front of the work surface and extend below the airfoil sill.
 9. Fume hood sash (Vertical): Full-view, frameless type with clear, unobstructed, side-to-side view of fume hood interior and service fixture connections. Sash to have a 35 inch (890 mm), nominal, sight line.
 - a. Counterbalance system: Single weight, counterbalance system to prevent sash tilting and permit ease of operation at any point along full width pull. Design system to hold sash at any position without creep and to prevent sash drop in the event of suspension system failure.
 - b. Sash Opening: Refer to the Laboratory Equipment Exhaust Schedule on the Laboratory Furnishings drawings for vertical access height clearance.
 - c. Sash Stop: Sash shall automatically self-close to 18 inch (457 mm) position when left at any dimension above the 18 inch (457 mm) working height, except when locked full-open for set-up. A manual, non-exposed lock-open feature shall be actuated from the front post to retain sash in full-open position for set-up.
 10. Ventilation Slots: Provide vertical ventilation slots along both sides of the enclosure, and provide perimeter exhaust slots to improve airflow through the enclosure.
 11. End and Center Divider Panels:
 - a. Typical: Glass framed with glazing gaskets.
 - b. Opaque Panel Inserts: Provide glass-reinforced polyester resin in lieu of glass panels where backs and sides of fume hood abut opaque walls.
- G. Finish Requirements
1. Preparation:
 - a. After the units have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish to the metal and to aid in the prevention of corrosion. Physical and chemical cleaning of the metal shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a heated cleaner/phosphate solution and pretreated with iron phosphate spray followed by a neutral final seal prior to application of final finish. The strength of each solution shall be monitored by filtration to insure consistent quality.
 - b. All treated parts shall be immediately dried in heated ovens and gradually cooled before application of the finish. Treated metal parts shall be clean and properly prepared to provide optimum adhesion of finish and resistance to corrosion.
 2. Application: Electrostatically apply powder coat of selected color and bake in controlled high temperature oven to assure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:
 - a. All surfaces, exterior or interior, exposed to view, shall receive sufficient powder coat to achieve an average 1.5 mil (38 μm) film thickness with a minimum 1.2 mil (30 μm) film thickness and shall have smooth satin luster.
 - b. Backs of cabinets and other surfaces not exposed to view shall have sufficient powder coat to achieve an average 1.0 mil (25 μm) film thickness.
 - c. Concealed interior parts shall receive corrosion-resistant treatment.
 - d. Stainless steel parts and surfaces shall not be powder coated.

3. Chemical Resistance Finish Performance Requirements:

- a. Test Procedure: Apply 10 drops (approximately 0.5 cubic centimeters) of each reagent identified to the surface of the finished test panels laid flat and level on a horizontal surface. Ambient temperature: 68°F to 72°F (20°C to 22°C). After one hour flush away chemicals with cold water and wash surface with detergent and warm water at 150°F (65.5°C) and with alcohol to remove surface stains. Examine surface under 100 foot-candles (1076 lux) of illumination.
- b. Evaluation Ratings: Change in surface finish and function shall be described by the following ratings:

0	No effect	No detectable change in the material surface.
1	Excellent	Slight detectable change in color or gloss but no change in function or life of the surface.
2	Good	A clearly discernable change in color or gloss but no significant impairment of surface life or function.
3	Fair	Objectionable change in appearance due to discoloration or etch, possibly resulting in deterioration of function over an extended period of time.
4	Failure	Pitting, cratering, or erosion of the surface. Damage to film and loss of adhesion and film protection. Obvious and significant deterioration.

4. Performance requirements: Test results for powder coat finish shall equal or exceed the following:

Reagent	% by weight	Rating
Acetic acid	50%	1
Acetic acid, glacial	98%	1
Acetone	50%	2
Ammonium hydroxide	25%	1
Amyl acetate		1
Benzene		1
Butyl alcohol		1
Carbon tetrachloride		1
Cresol		1
Dimethyl formamide		2
Dioxane		2
Ethyl alcohol		1
Ethyl acetate		2
Ethyl ether		1
Formaldehyde		1
Furfural		2
Gasoline		1
Glycerin		1
Hydrochloric acid	10%	1
Hydrochloric acid	20%	1
Hydrochloric acid	37%	1
Hydrofluoric acid	48%	2
Hydrogen peroxide	30%	1
Kerosene		2
Methyl alcohol		1
Methyl ethyl ketone		2
Monochlorobenzene		1
Naphthalene (dissolved in Toulene)		2

Reagent	% by weight	Rating
Nitric acid	10%	1
Nitric acid	30%	1
Phenol	85%	2
Phosphoric acid	25%	1
Phosphoric acid	75%	1
Potassium hydroxide	45%	1
Silver nitrate (10% aqueous solution)		1
Sodium carbonate, saturated		1
Sodium chloride, saturated		1
Sodium hydroxide	40%	1
Sodium hydroxide	50%	1
Sodium hypochlorite	5.25%	1
Sodium sulfide, saturated		1
Sulfuric acid	50%	1
Sulfuric acid	70%	1
Tincture of Iodine		2
Toulene		1
Trichloroethylene		2
Xylene		1
Zinc chloride, saturated		1

Note: Maximum concentration is to be understood unless a lower concentration is shown in the table.

a. Physical Tests:

- 1). Abrasion: Finish shall have high abrasion resistance with maximum weight loss of 5.5 mg per 100 cycles as tested on a Taber Abrasion Tester No. E40101 with 1000 gm wheel pressure and Calibrase No. CS10 wheel.
- 2). Hardness: Finish shall have surface hardness equivalent to 4H or 5H pencil lead.
- 3). Humidity: Finish shall withstand 1000 hours exposure in saturated atmosphere at 100°F (38°C).
- 4). Moisture: Finish shall withstand the following procedures with no visible effect:
 - a). Boiling water flowing over 45 degree inclined surface for 5 minutes.
 - b). 100 hours continuous contact with water-soaked cellulose sponge, maintained in a wet condition throughout test.
- 5). Adhesion: Finish shall withstand the following test procedure with at least 95 squares maintaining their finish. Using a razor blade, score the finish surface of the test panel through to the substrate with a pattern of 100 squares, each 1/16 inch x 1/16 inch. Brush away loose particles with a soft brush.
- 6). Salt spray: Finish shall withstand 200 hours exposure to salt spray test.

H. Fume Hood Liner Test: Polyresin

1. Test No. 1: Spills and Splashes:

- a. Suspend a 42 inches (1067 mm) x 12 inches (305 mm) panel (42 inch (1067 mm) dimension horizontal) in a position to expose the surface to be tested in a vertical plane. Divide the panel vertically into 3/4 inch (19 mm) spaces.
- b. Using an eyedropper, apply five drops of each reagent as listed.

- c. Liquid reagents shall be applied at the top of the panel and permitted to flow down full panel height. (CAUTION! Flush away any reagent drops.)
2. Test No. 2: Fumes and Gases:
- a. Prepare a panel 24 inches (610 mm) x 12 inches (305 mm) by dividing panel into 2 inch (51 mm) squares. Using 100 ml beakers, place 25 ml (approximately 1/2 inch (13 mm) of reagent) into each beaker. Place beakers in position so that test panel may be placed over beaker tops in the proper sequence. Place panel over beakers. Note: Beaker pouring lip permits atmospheric oxygen to enter and participate in the reaction of the reagent fumes.
- b. After a 24 hour time period has elapsed, remove panel, flush off with water, clean with naphtha and detergent, rinse and wipe dry. Evaluate.

3. Evaluating Ratings:

0	No effect	No detectable change in the material surface.
1	Excellent	Slight detectable change in color or gloss but no change in function or life of the surface.
2	Good	A clearly discernable change in color or gloss but no significant impairment of surface life or function.
3	Fair	Objectionable change in appearance due to discoloration or etch, possibly resulting in deterioration of function over an extended period of time.
4	Failure	Pitting, cratering, or erosion of the surface. Obvious and significant deterioration.

4. Performance: Test results shall equal or exceed the following:

Reagent	% by wt.	Spills	Fumes
Acetic acid, glacial		0	0
Acetone		0	0
Acid dichromate		1	1
Ammonium hydroxide	28%	0	0
Amyl acetate		0	0
Benzene		0	0
Butyl alcohol		0	0
Carbon tetrachloride		0	0
Chloroform		0	0
Chromic acid, saturated		3	0
Cresol		0	0
Dichloro acetic acid	93%	0	0
Dimethyl formamide		0	0
Dioxane		0	0
Ethyl acetate		0	0
Ethyl alcohol		0	0
Ethyl ether		0	0
Formaldehyde	37%	0	0
Formic Acid	88%	0	0
Furfural		2	0
Gasoline		0	0
Hydrochloric acid	48%	1	1
Hydrofluoric acid	37%	0	0
Hydrogen peroxide	30%	0	0
Methyl alcohol		0	0
Methyl ethyl ketone		0	0

Reagent	% by wt.	Spills	Fumes
Methylene chloride		0	0
Monochlorobenzene		0	0
Naphthalene		0	0
Nitric acid	20%	0	0
Nitric acid	30%	0	0
Nitric acid	70%	0	0
Phenol	85%	0	1
Phosphoric acid	85%	1	0
Silver Nitrate	10%	1	0
Sodium Hydroxide	10%	1	0
Sodium Hydroxide	20%	1	0
Sodium Hydroxide	40%	1	0
Sodium Hydroxide Flake		0	0
Sodium Sulfide, saturated		2	1
Sulfuric acid	33%	1	0
Sulfuric acid	77%	1	0
Sulfuric acid	93%	1	0
Sulfuric acid/Nitric acid, equal parts	77%/70%	0	1
Tincture of Iodine		0	2
Trichloroethylene		0	0
Toluene		0	0
Xylene		0	0
Zinc Chloride		0	0

Note: Maximum concentration is to be understood unless a lower concentration is shown in the table.

2.3 FUME EXTRACTOR ARMS (SNORKELS)

- A. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.
1. Alsident System represented by Laboratory Enterprises, 3122 Brinkerhoff Road, Kansas City, KS 66115 Tel: 913 621-7337.
 2. Movex Inc., 104 Commerce Drive, Suite C, Northampton, PA 18067 Tel: 610 440-0478.
 3. Nederman Inc., 39115 West Warren Road, Westland, MI 48185 Tel: 800-575-0609.
 4. Approved substitution.
- B. Models: Subject to compliance with the requirements listed below, acceptable models include:
1. System 75 by Alsident System.
 2. MET by Movex.
 3. FX Extractor Arms by Nederman Inc.
- C. Type: Ceiling mounted, self-supporting fume extractor arm.
- D. Characteristics:
1. Extractor Arm Diameter:
 - a. 3 inch diameter tubes.
 2. Extractor Arm Material:
 - a. Anodized aluminum.

3. Arm Length: Arms shall be of sufficient length to cover an 18 inch radius area at 48 inches above the finished floor.
 - a. Assembly shall be positioned so that no component is lower than 90 inches above the finished floor.
4. Swivel Assembly: Hi-grade cast aluminum with 360 degree rotation.
5. Joints: Friction joints with ball bearings and O-ring.
 - a. Provide external, corrosion-resistant adjustment knobs.
6. Gas Spring: Provide gas spring to support upper friction joint to provide stable positioning of articulated snorkel arm.
7. Hood (metal): 10 inch diameter, powder-coated aluminum.
8. Ceiling mounted stanchion/bracket for attachment to structure above.
9. Escutcheon suitable to trim any ceiling penetrations.
10. Final connection to the fume exhaust duct system under Division 23. Provide airflow per Equipment Exhaust Schedule.
11. Dampers are not acceptable and shall not be provided.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

- A. Prior to installation of the Work of this Section, carefully inspect the installed Work specified in other sections and verify that all such Work is complete to the point where this installation may properly commence.
- B. Verify that all Work has been installed in complete accordance with the original design, received submittals, and the manufacturer's recommendations.
- C. In the event of discrepancy, immediately notify the Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 INSTALLATION

- A. Work in this Section requires close coordination with Work specified in Division 22, Division 23 and Division 26, as well as installation by Owner of Owner furnished components. Coordinate all Work to ensure an orderly process in the Project, without removal of previously installed Work, and so as to prevent damage to finishes and products.
- B. Coordinate location and alignment of fume hoods and cabinets for proper connection of all piping and duct work.
- C. Install all equipment in accordance with applicable codes and regulations, accepted Shop Drawings, and as necessary for a complete operating system.

3.3 FIELD TESTING

- A. Chemical Fume Hoods Containment:
 1. Fume hood field tests shall be performed by a qualified independent testing company on each hood.
 2. All laboratory supply, general exhaust, and fume exhaust HVAC systems shall be operational during testing.

3. Test and certify each fume hood in accordance with ASHRAE Standard 110-2016 for Section 6.1 Flow Visualization, Section 6.2 Face Velocity Measurements, Section 6.3 Test Method for VAV Fume Hoods, Section 6.4 VAV Response Test, and Section 7 Tracer Gas Test Procedure testing requirements.
4. Flow Visualization: Fume hood shall provide complete containment of the smoke generated within the hood.
5. Face Velocity Measurements: Fume hoods shall be tested at the design operating condition sash opening height indicated in the Chemical Fume Hood Schedule.
 - a. Fume hoods shall achieve the scheduled design operating condition average face velocity within ± 5 fpm.
 - b. Individual face velocity readings shall not vary by more than 20% of the mean between measurement grid locations.
6. Test Method for VAV Fume Hoods (Not Applicable to CAV Hoods): Perform this test to confirm VAV controls are properly calibrated. Average and individual face velocity reading should meet the performance criteria indicated for Section 6.2 Face Velocity Measurements above.
7. VAV Response Test (Not Applicable to CAV Hoods): Perform this test to verify VAV controls are responding accurately to the opening of the fume hood sash. The time it takes from the start of the sash movement until the face velocity stabilizes shall be less than 5 seconds.
8. Tracer Gas Test Procedure: Fume hoods shall achieve an As-Installed (AI) performance rating equal or better than 0.10 ppm with 4.0 Lpm tracer gas release rate.
9. Cross Drafts: Fume hood testing shall also include measuring and documenting the vertical and horizontal cross-drafts at the face of the hood. Cross-drafts shall not exceed half of the fume hood face velocity.
10. Balancing of the HVAC systems is in the scope of work of Division 23.

3.4 CLEANING AND PROTECTION

- A. Repair or remove and replace defective work as approved by the Architect upon completion of installation.
- B. Adjust all moving or operating part to function within their design parameters.
- C. Clean equipment, touch up as required.
- D. Protect all units before, during, and after installation. Damaged materials due to improper protection shall be cause for rejection.

END OF SECTION 115313

SECTION 115343 - LABORATORY SERVICE FITTINGS AND FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Laboratory service fittings, valves, and related components.
- B. Laboratory emergency plumbing fixtures.
- C. Laboratory sink units.

1.2 RELATED SECTIONS

- A. Division 22: Plumbing
- B. Section 222000: Laboratory Plumbing
- C. Division 23: Heating, Ventilated, and Air Conditioning (HVAC)
- D. Division 26: Electrical

1.3 REFERENCES

- A. Conform to SEFA 2-2010 Recommended Practices for Installation and SEFA 7-2010 Recommended Practices for Laboratory Fixtures as published by the Scientific Equipment and Furniture Association.

1.4 DESCRIPTION

- A. Work includes but is not necessarily limited to furnishing to the project site for installation by Division 22, all laboratory fixtures, fittings, and emergency plumbing fixtures described herein and shown on the Laboratory Furnishings Drawings.

1.5 SUBMITTALS

- A. Refer to General Conditions and Division 1 "Submittal Procedures" for submittal requirements. In addition to these requirements, provide submittal requirements specified herein.
- B. Submittal requirements:
 - 1. Submittal shall be prepared individually for this specification section. Arrange product data, drawings and information for submission in a complete set for this specification section.
 - 2. Submittal shall contain complete data for all items of this specification section. Periodic or partial submittals of individual components within this specification section will be returned as incomplete and rejected.
 - 3. Submittals shall be organized by specification sequence with section and paragraph number identified.
 - 4. Equipment and components being proposed shall be clearly labeled with all options and accessories indicated and shall be for this specific project.
- C. Materials List/Product Data: Submit complete materials list, including catalogue data, of all materials, equipment, and products for Work in this Section.

- D. Shop Drawings: Submit complete shop fabrication and installation drawings, including plans, elevations, sections, details and schedules. Show relationship to adjoining materials and construction. Shop Drawings shall be in the form of reproducible or photocopies, not to exceed 11 inches by 17 inches (A3) in size. Blueline prints are not acceptable.
- E. Approved Substitution/Approved Equal: In addition to the items required in Division 1, all substitution requests shall include item-by-item comparison of the proposed substitution to this project specification. A copy of the project specification shall be submitted, with each item and subsection of the project specification marked as "Comply" or "Not Comply." In any cases where "Not Comply" is indicated, an explanation of the relative advantages of the proposed design shall be provided.
 - 1. Substitution shall not affect dimensions shown on Drawings.
 - 2. The Contractor shall pay for changes to the building design, including engineering design, detailing, utility and service requirements, and construction costs caused by the requested substitution.
 - 3. Substitutions shall have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
 - 4. Maintenance and service parts shall be locally available for the proposed substitution.
- F. Samples: Submit two (2) samples of each type of specified finish and color specified.
- G. Certifications: As a condition of acceptance, submit certification stating that equipment is complete and ready for intended function.
- H. Operations/Maintenance Manuals: Accompanying certification, submit for Architect's review and Owner's use, complete operating and maintenance manuals that describe proper operating procedures, maintenance and replacement schedules, components parts list, and closest factory representative for components and service.

1.6 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect work of this section before, during and after installation including installed work and materials of other trades.
- B. Replacement: Any damaged work shall be replaced, repaired and restored to original condition to the approval of the Architect at no additional cost or inconvenience to the Owner.

1.7 QUALIFICATIONS

- A. Work in this section shall be performed by a company having a minimum of eight years documented experience, and an established organization and production facilities including all tools, equipment and special machinery necessary for specializing in the fabrication and installation of the type of equipment required, with skilled personnel, factory trained workmen and an experienced engineering department. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.
- B. Work in this Section requires close coordination with Work in electrical and mechanical Sections. Coordinate all Work to assure an orderly progress in the Project, without removal of previously installed Work, and so as to prevent damage to finishes and products.
- C. Review conditions of installation, procedures and coordination with related Work.

- D. Carefully inspect the installed Work specified in other Sections and verify that all such Work is complete and ready for the installation of this Work to properly commence.
- E. Verify that all Work may be installed in complete accordance with the original design, reviewed submittals and manufacturer's recommendations.

1.8 WARRANTY

- A. All products will be warranted to be free from defects in materials and workmanship for a period of one year following substantial completion. The manufacturer/dealer/subcontractor shall repair or replace any products (or parts thereof) that are found to be defective. Replacement will include any parts, labor, shipping, and travel expenses involved. Warranty replacement work must be scheduled in coordination with the Owner's academic/research schedule, and may therefore require evening and/or weekend work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All service fittings and emergency plumbing fixtures shall be specifically designed for laboratory use.
- B. Service fittings, emergency fixtures, sinks, etc. specified in this Section shall be furnished and delivered to point of use for installation as specified in Division 22.
- C. All service fittings shall be factory pre-assembled including the assembly of valves to turrets, mounting shanks to turrets, etc., and individually factory tested.
- D. All laboratory service fittings shall be the product of one service fitting manufacturer to assure ease of replacement and maintenance.
- E. All service valves, fittings, turrets, flange and accessories shall be forged brass with a minimum copper content of 85%.
- F. Provide fittings as shown in laboratory fitting details for all laboratory equipment at locations shown on the Laboratory Furnishings drawings. See Service Fitting Schedule.
- G. Assembly components and operating parts such as valve stems, renewable units, packing nuts, outlet nozzles and straight serrated hose ends shall be made from solid brass stock.
- H. Replaceable seats, needle cones, valve disc screws and other accessories shall be Monel or stainless steel alloys especially selected for use intended.
- I. Fittings shall be factory tested and shall be supplied with nipples, lock nuts, shanks, etc.
- J. Serrated tip fittings shall be threaded with the hose end being tapered.
- K. Turrets shall be brass drop forging of design indicated in details shown elsewhere in the Section and shall be one or two-way, as required, with 3/8 inch (9.525 mm) IPS female inlet thread for connections. Units shall be furnished with brass shanks, brass locknuts, and washers.
- L. Fittings located on the same plane shall have their handles project the same distance from the plane of reference to present a uniform related appearance, regardless of valve type construction.

- M. Flanges shall be brass forging of approved design with 3/8 inch (9.525 mm) IPS female inlet and outlet.
- N. All goosenecks shall provide full thread for attachment of aerator or serrated hose ends.
- O. Hot water/cold water gooseneck mixers and wall-mounted cold water goosenecks shall swivel. Swivel point shall be above valve body or at valve level if wall mounted. Swing joints shall have heavy Teflon type packings; "O" rings will not be permitted. Cold water goosenecks at cup sinks shall be rigid.
- P. All fittings shall have plastic colored service index buttons as specified in this Section.
- Q. Provide approved backflow preventers at hand held drench hoses. See details on Laboratory Furnishings drawings.
- R. Provide durable 1inch x 3 inch (25 x 75 mm) sign "NONPOTABLE WATER, DO NOT DRINK" at each bench mounted industrial water fitting, see details on Laboratory Furnishings drawings.
- S. Fittings and fixtures designated to be accessible to persons with disabilities (ADA) with operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds (22.2 N), maximum.

2.2 LABORATORY SERVICE FITTINGS

A. Manufacturers:

- 1. Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.
 - a. Water Saver Faucet Co., 701 West Erie Street, Chicago, IL 60610 Tel: 312 666-5500.
 - b. T&S Brass and Bronze Works, Inc., 2 Saddleback Cove, P. O. Box 1088, Travelers Rest, SC 29690 Tel: 800 476-4103.
 - c. Approved substitution.

B. Cylindrical Pattern:

- 1. All service fittings shall have WaterSaver Standard turret style (not ColorTech) as the basis of design.

C. Handles:

- 1. Faucets designated to be accessible to persons with disabilities (ADA): provide 4 inch "wrist-blade" handles with color coded screw-on index (identification) discs. Wrist-blade handles to be installed in the vertical position (off).
 - a. Handles to swivel towards the user when turned on.
- 2. Laboratory gas, nitrogen, and vacuum valves at workstations indicated to be accessible to persons with disabilities (ADA): Provide ball valves fitted with lever-type handles and color coded screw-on index (identification) discs.
- 3. Other fittings shall be fitted with color-coded hooded type handles and screw-on index discs.

- a. For laboratory gas at non-accessible (non-ADA) workstations provide push/turn gas valve assembly, powder coated metal hooded handle with pop-up indicator and screw-on index discs.
- D. Finish: As described elsewhere in this section.
- E. Water Valves:
1. Water valves shall include one of the following options:
 - a. A renewable unit containing all the working parts which are subject to wear, including stainless steel or monel seat, monel screw and heavy duty seat disk and Teflon packing.
 - b. A renewable ceramic disk.
 2. Volume control at deck mounted water faucets:
 - a. Compression unit with integral adjustable volume control to regulate size of inlet port of valve.
 3. Volume control at fume hood water outlets: Serrated hose end shall have a 0.5 GPM removable flow restrictor insert to allow a perfect flow out of the outlet and eliminate any splashing or wide pattern spray.
 4. Goosenecks: Unit shall be capable of being readily converted from compression to self-closing, and vice versa, without disturbing faucet body and shall also be capable of being readily converted from water construction to needle valve or steam valve construction having outside packing gland without disturbing faucet body.
 5. Unit shall be sealed in valve body with special composition gasket. Metal-to-metal or ground joint type of sealing is not acceptable.
 6. Water fixtures shall be fully assembled and factory tested at 80 psi (0.55 MPa) water pressure.
- F. Needle Valves: Fully assembled and factory tested at 225 psi (1.55 MPa) air pressure. Gas, air, vacuum and steam needle valve fittings shall have stainless steel replaceable floating cone that is precision ground and self-centering which shall seat against a stainless steel or monel renewable valve seat. Action of valve shall be slow compression for fine control under pressure up to 150 psi (1.03 MPa) and shall have subject-to-wear parts easily replaceable. Provide pressure regulators designed for use with the appropriate service at locations indicated on the Laboratory Furnishing drawings. Needle valves for fuel (laboratory) gas service shall be certified for use with fuel gas by the Canadian Standards Association under ANSI Z21.15-2009/CGA 9.1-2009. Needle valves in fume hoods shall be mounted on the front panel of the fume hood, with all components subject to wear accessible from the exterior face of the hood.
- G. Laboratory Ball Valves: Suitable for laboratory gas, air and vacuum and be supplied fully assembled and factory tested at 125 psi (0.86 MPa) air pressure. Ball valves shall be of quarter-turn (closed to fully open) design, be fitted with lever handle requiring less than 5 lbf (22 N) force to operate, and shall have subject-to-wear parts easily replaceable. Ball valves for fuel (laboratory) gas service shall be certified for use with fuel gas by the Canadian Standards Association under ANSI Z21.15-2009/CGA 9.1-2009.
- H. High Purity Water Valves: Suitable for purified water and provided with polypropylene liner. Valve stem and bonnet shall be brass.

I. Service Fitting Color Index:

Service Name	Disc Color	Letters	Letter Color
Laboratory Gas	Dark Blue	GAS	White
Laboratory Vacuum	Yellow	VAC	Black
Industrial Cold Water	Dark Green	ICW	White
Industrial Hot Water	Red	IHW	White
Purified Water	White	PW	Black
Nitrogen	Brown	N2	White

2.3 LABORATORY EMERGENCY PLUMBING FIXTURES

A. Manufacturers:

1. Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
 - a. Water Saver Faucet Co., 701 West Erie Street, Chicago, IL 60610 Tel: 312 666-5500.
 - b. Guardian Equipment, 1104N North Branch St., Chicago, IL 60642 Tel: 312 447-8100.
 - c. Haws Corporation, 1455 Kleppe Lane, Sparks, NV 89431 Tel: 775 359-4712.
 - d. Approved substitution.

B. All emergency plumbing fixtures shall comply with requirements of ANSI/ISEA Standard Z358.1-2014: American National Standard for Emergency Eyewash and Shower Equipment.

C. All emergency plumbing fixtures shall be accessible to persons with disabilities in compliance with the requirements of the federal Americans with Disabilities Act (ADA), ADA Accessibility Guidelines (ADAAG), and state accessibility regulations.

D. Barrier-free safety station with emergency shower actuation valve in stainless steel cabinet for recess mounting and wall-mounted eyewash with stainless steel skirt: Water Saver Model No. SSBF670-721, or equal, with the following characteristics or modifications.

1. Ceiling-mounted exposed showerhead. Nipple length shall be as required for a complete installation; verify finished ceiling height.
2. Exposed piping, showerhead, nipple, and escutcheon shall be chrome-plated brass with clear epoxy coating.
3. Safety shower actuating arm shall be stainless steel.
4. Showerhead shall have perforated stainless steel spreader.
5. Safety shower actuating arm shall be mounted in a flanged, recessed-mounted 18 gauge (1.3 mm) stainless steel cabinet with No. 4 finish.
6. Flag/paddle shall be epoxy-coated cast aluminum or stainless steel.
7. Eyewash heads shall be ABS plastic with float-off dust covers.
8. Stainless steel skirt shall have No. 4 finish.
9. Safety shower stay-open brass ball valve concealed behind stainless steel/access panel housing. Eyewash stay open brass ball valve concealed behind skirt.
10. Fixture shall be furnished with green plastic sign with graphic symbol for safety shower/eyewash.

2.4 FINISHES

A. Service Fittings Finishes (Unless otherwise noted):

1. Polished chrome finish with clear, acid-resistant coating:
 - a. Chrome finish: All exposed surfaces shall be polished and buffed, then electroplated with one layer of nickel and one layer of chrome. Each layer of plating shall completely cover all visible areas. Total plating thickness shall be not less than 0.4 mil (10 μm).
 - b. Clear epoxy coating: Following plating, clear epoxy coating shall be applied to all exposed surfaces and then baked to permit curing. Surfaces shall have a minimum coating thickness of 2 mils (50 μm).

- B. Service Fittings inside Fume Hoods:
 1. Preparation: Surfaces to be coated shall be polished or sandblasted to produce a uniform fine-grained surface and immersed in a phosphoric acid cleaning solution to remove thoroughly all oil, grease and other foreign substances.
 2. Epoxy finish: Following cleaning, coating material shall be electrostatically applied to all exposed surfaces. After application, coating shall be fully baked to permit curing. Coating material shall be free-flowing epoxy powder with particle size of 1.4 to 2.8 mils (35 to 70 μm) or polyester powder coating. Surfaces shall have a minimum finished coating thickness of 2 mils (50 μm).
 3. Color:
 - a. Fittings inside fume hoods shall have a colored finish color-coded to match the fitting service index color.
 - b. Finishes of fittings outside fume hoods to match all other fittings.

- C. Performance requirements for coated finishes:
 1. Chemical resistance:
 - a. Fume Test: Suspend coated samples in a container of at least 6 cu. foot (170 L) capacity, approximately 12 inches (300 mm) above open beakers, each containing 100 mL of 70% nitric acid, 94% sulfuric acid and 35% hydrochloric acid, respectively. After exposure to these fumes for 150 hours, the finish on the samples shall show no discoloration, disintegration or other effects.
 - b. Direct Application Test: Subject coated samples to the direct action of the following reagents and solvents at a temperature of 25°C dropping from a burette at the rate of 60 drops per minute for ten minutes. Finish on samples shall not rupture, though slight discoloration or temporary softening is permissible.

Reagent	Concentration
Acetic Acid	98%
Acetone	
Ammonium Hydroxide	28%
Amyl Acetate	
Amyl Alcohol	
Benzene	
Butyl Alcohol	
Calcium Hypochlorite	
Carbon Disulfide	
Carbon Tetrachloride	
Chloroform	
Chromic Trioxide Acid	
Cresol	
Crude Oil	

Reagent	Concentration
Dioxane	
Distilled Water	
Ether	
Ethyl Acetate	
Ethyl Alcohol	
Ethyl Ether	
Formaldehyde	37%
Formic Acid	90%
Gasoline	
Glacial Acetic Acid	99.5%
Glycerine	
Hydrochloric Acid	38%
Hydrofluoric Acid	48%
Hydrogen Peroxide	5%
Isopropyl Alcohol	
Lactic Acid	10%
Kerosene	
Methanol	
Methyl Alcohol	
Methyl Ethyl Ketone	
Methylene Chloride	
Mineral Oil	
Monochlor Benzene	
N-Hexane	
Naphthalene	
Nitric Acid	70%
Perchloric Acid	70%
Phenol	
Phosphoric Acid	75%
Sea Water	
Silver Nitrate	30%
Sodium Bichromate	Saturated
Sodium Carbonate	10%
Sodium Chloride	20%
Sodium Hydroxide	50%
Sodium Hypochlorite	
Sodium Sulfide	
Sulfuric Acid	87%
Toluene	
Trichlorethylene	
Turpentine	
Urea	Saturated
Xylene	
Zinc Chloride	Saturated

2. Mar and abrasion resistance: Coating material shall have a pencil hardness of 2H – 4H with adhesion substantial enough to withstand both direct and reverse impacts of 160 inch-pounds (18 Nm). Coating shall have excellent mar resistance and be capable of withstanding scuffing, marring and other ordinary wear.
3. Repairability: Scratches and other localized surface damage shall be field-repairable.

2.5 LABORATORY SINKS

- A. Epoxy Resin:

1. Manufacturer: Manufacturer shall be the manufacturer of epoxy resin work surfaces specified in Section 115310.
 2. Laboratory Sinks:
 - a. Drop-in Type: Drop-in installation by Division 11 in epoxy resin work surface, sizes as indicated on drawings. Color to match work surface.
 - b. Comply with the requirements of Section 115310 for epoxy resin.
 - c. All exposed edges shall be radiused not less than 1/4 inch (6 mm).
 - d. Sink shall be set 1/8 inch (3 mm) below the level of the adjacent surface.
 - e. Provide epoxy resin sink outlet in color to match sink with strainer, stopper and open-end overflow, and install in sink with continuous bead of silicone sealant.
 - 1). At black epoxy resin sinks, outlet shall be black polypropylene.
 - f. Provide tailpiece compatible with waste piping system for all sinks unless otherwise specified. Refer to Division 22 for piping requirements.
- B. Epoxy resin, Polyolefin or Polypropylene Cup Sinks:
1. Fume Hood Locations: Provide cup sinks at fume hoods as described in Section 115313.
 2. Provide matching strainer for all cup sinks.
- C. Stainless steel:
1. Laboratory Sinks:
 - a. Refer to Section 115310, Stainless Steel Fabrications.
 - b. Provide stainless steel strainer, outlet, standpipe overflow and stopper for all sinks unless otherwise specified.
 - c. Provide tailpieces compatible with waste piping system for all sinks unless otherwise specified. Refer to Division 22 for piping requirements.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

- A. Inspection:
1. Prior to installation of fittings specified in Section 115343, carefully inspect the installed Work specified in other Sections and verify that all such Work is complete to the point where this installation may properly commence.
 2. Verify that all Work has been installed in complete accordance with the original design, approved submittals, and the manufacturer's recommendations.
- B. Discrepancy:
1. In the event of discrepancy, immediately notify the Architect.

3.2 PACKING AND DELIVERY

- A. Deliver all fittings and fixtures to job site in recommended packaging, with each fitting individually packaged, marked, and scheduled for point of use.
- B. Inventory fittings, at job site, verify that type and quantity are correct, and re-package until installed.

- C. Store in clean, dry location.

3.3 INSTALLATION

- A. Set internal volume control on all cup sink water fittings so that water does not splash out of sink.
- B. Products to be installed in strict compliance with manufacturer's installation manuals and to comply with SEFA 2.

END OF SECTION 115343

SECTION 115350 - LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Laboratory Sterilizers (Autoclaves): Small – Manual Operation
- B. Laboratory Sterilizers (Autoclaves): Small
- C. Laboratory Glassware Washer/Dryers: Base Cabinet Height
- D. Laboratory Glassware Washer/Dryers: Tall
- E. Products installed but not supplied under this section: Owner's existing under counter (base cabinet height) glassware washer. Work includes, but is not limited to, disconnection and installation in new location as shown in compliance with manufacturer's recommendations. Contractor responsible to provide all materials, labor, and equipment to provide a complete and properly functioning installation including, but not limited to, all required disassembly, protection of Owner's property, storage as required, transportation to new location, code compliance, coordination with all other Divisions, start up and testing as specified in this Section. Work must be coordinated with Owner's schedule requirements.

1.2 RELATED SECTIONS

- A. General and Supplementary Conditions and Division 1
- B. Division 23: Mechanical
- C. Division 22: Plumbing
- D. Division 26: Electrical

1.3 REFERENCES

- A. Comply with requirements of general and supplementary conditions and Division 1 as part of this specification.

1.4 DESCRIPTION

- A. Furnish and install all laboratory equipment with necessary components and accessories required to ensure a complete installation and ready for intended use as specified herein and shown on the Laboratory Furnishings Drawings.
- B. Provide side panels to cover all exposed sides of cabinet-type equipment designed for under-counter installation.

1.5 SUBMITTALS

- A. Refer to General Conditions and Division 1 "Submittal Procedures" for submittal requirements. In addition to these requirements, provide submittal requirements specified herein.
- B. Submittal requirements:

1. Submittal shall be prepared individually for this specification section. Arrange product data, drawings and information for submission in a complete set for this specification section.
 2. Submittal shall contain complete data for all items of this specification section. Periodic or partial submittals of individual components within this specification section will be returned as incomplete and rejected.
 3. Submittals shall be organized by specification sequence with section and paragraph number identified.
 4. Equipment and components being proposed shall be clearly labeled with all options and accessories indicated and shall be for this specific project.
- C. Shop Drawings: Submit complete shop fabrication and installation drawings, including plans, elevations, sections, details and schedules. Show relationship to adjoining materials and construction. Shop Drawings shall be in the form of reproducible or photocopies, not to exceed 11 inches x 17 inches (A3) in size. Blueline prints are not acceptable.
- D. Submit detailed anchorage and attachment drawings and calculations provided by a licensed Structural Engineer to show compliance with the applicable Building Code seismic restraint requirements.
- E. Samples: Submit for Architect's approval two (2) samples of each type of specified finish and color range available.
- F. Certifications: As a condition of acceptance, submit certification stating that equipment is complete and ready for intended function.
- G. Operations/Maintenance Manuals: Accompanying certification, submit for Architect's review and Owner's use, complete operating and maintenance manuals that describe proper operating procedures, maintenance and replacement schedules, components parts list, and closest factory representative for components and service.

1.6 QUALIFICATIONS

- A. Contractor for work in this section shall have an established organization and production facilities including all tools, equipment and special machinery necessary for specializing in the fabrication and installation of the type of equipment specified, with skilled personnel, factory trained workmen and an experienced engineering department. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.

1.7 COORDINATION

- A. Work of this section requires close coordination with work of Division 22, 23 and 26 as well as installation of Owner furnished components and work specified in other Sections. Sequence all work to assure an orderly progress in the project without removal of previously installed work and so as to prevent damage to finishes and products.

1.8 SUBSTITUTIONS

- A. Approved Substitution/Approved Equal: In addition to the items required in Division 1, all substitution requests shall include item-by-item comparison of the proposed substitution to this project specification. A copy of the project specification shall be submitted, with each item and subsection of the project specification marked as "Comply" or "Not Comply." In any cases where "Not Comply" is indicated, an explanation of the relative advantages of the proposed design shall be provided.

- B. Substitution shall not affect dimensions shown on Drawings.
- C. The Contractor shall pay for changes to the building design, including engineering design, detailing, utility and service requirements, and construction costs caused by the requested substitution.
- D. Substitutions shall have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
- E. Maintenance and service parts shall be locally available for the proposed substitution.
- F. Regulatory: Specified products, materials, or systems for Project may include engineering or on file standards required by the Regulatory Agency. Contractor's substitution of products, materials or systems may require additional engineering, testing, reviews, approvals, assurances, or other information for compliance with Regulatory Agency requirements or both. Contractor shall provide all Agency approvals or other additional information required and pay additional costs for required Architect's services made necessary by the substitution at no increase in Contract Sum or schedule time, and as a part of substitution proposal

1.9 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect work of this section before, during and after installation including installed work and materials of other trades.
- B. Replacement: Any damage as a result of this contractors work will be replaced, repaired and restored to original condition to the approval of the Architect at no additional cost or inconvenience to the Owner.

1.10 WARRANTY

- A. Refer to the General Conditions and Division 1 "Product Requirements" for warranty requirements. In addition to these requirements, all products will be warranted to be free from defects in materials and workmanship for a minimum period of one year following substantial completion. The manufacturer/ dealer/ subcontractor shall repair or replace any products (or parts thereof) that are found to be defective. Replacement will include any parts, labor, shipping, and travel expenses involved.
- B. Autoclave chambers shall be warranted to be free from defects in materials and workmanship for a minimum period of 15 years following substantial completion.

PART 2 - PRODUCTS

2.1 LABORATORY STERILIZER (AUTOCLAVE): SMALL – MANUAL OPERATION

- A. Manufacturers: Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
 - 1. Market Forge Industries, Inc., <http://www.mfii.com>.
 - 2. Consolidated Sterilizer Systems, <http://www.consteril.com>
 - 3. Approved equal.
- B. Description: Small size steam-jacketed sterilizer designed for use in Laboratory and industrial applications.

- C. Basis of Design: Sterilmatic Sterilizer (Autoclave), Model STM-EL with accessory water cooled steam condenser unit, as manufactured by Market Forge Industries, Inc.
- D. Chamber Size:
 - 1. 16 inches diameter x 26 inches (406 x 660 mm) nominal.
- E. Door/Mounting Configuration:
 - 1. Single self-sealing hinged door, cabinet enclosed unit.
- F. Operation:
 - 1. Sterilizing cycle will be fully automatic, time-controlled and have a built-in temperature control which provides 2,500 °F (1,210 °C). Model STM-EL has the additional feature of an adjustable temperature control that can be set anywhere from 2,300-2,500 °F (1,100-1,210 °C) range. All operating controls will be located at the top, front of the sterilizer. Pressure will be automatically and quickly exhausted, and power supply shut off at termination of cycle. Slow exhaust may be selected for sterilizing liquids.
- G. Steam Source:
 - 1. Internal generation supplied manually with water.
- H. Product Characteristics:
 - 1. Construction:
 - a. Cylinder: Sterilizing cylinder will be 3/16" (4.8mm) wall welded aluminum. Sterilizer exterior is made of polished stainless steel. Interior dimensions of 16" (406mm) in diameter and 26" (660mm) long with a cubic content of 5,220 cubic inches (0.085 cubic meters) and will have a door opening of 13 1/2" (343mm) wide and 11" (279mm) high. Sterilizing compartment will have a capacity of:
 - 1). (3) 12" x 20" x 2 1/2" (305mm x 508mm x 64mm) or,
 - 2). (2) 12" x 20" x 4" (305mm x 508mm x 102mm) or,
 - 3). (1) 12" x 20" x 6" (305mm x 508mm x 152mm).
 - b. Sterilizer door: self-sealing type which cannot be opened until steam pressure is completely exhausted; 12-gauge stainless steel, removable for cleaning without tools. Door gasket will be one piece molded, replaceable without tools or cement.
 - c. Standard Features:
 - 1). Automatic temperature control
 - 2). Thermometer 1,800-3,000 °F (820-1,490 °C)
 - 3). Safety valve
 - 4). 0-30 lb. steam gauge
 - 5). 0-60 minute timer
 - 6). Low water cut-off
 - 7). Thermostatic steam trap
 - 8). Signal light
 - 9). Flat perforated steam baffle
- I. Utilities:
 - 1. Drain for autoclave: ½ inch (13 mm) FTP of 5/8 inch (16 mm) OD copper to adjacent floor sink. An air break must be provided.

2. Drain for steam condenser unit: 1 inch (26 mm) IPS to adjacent floor sink. An air break must be provided.
 3. Cold Water: ½ inch IPS cold water connection for steam condenser units.
 4. Purified Water: Manual fill from adjacent ball valve.
 5. Electrical Connection: 208 V, 60 Hz, 3-phase, 4 wire, 26A, 12 kW for autoclave. Unit must be grounded. Main supply voltage fluctuations are not to exceed +/- 10% nominal supply voltage.
 6. Electrical Connection: 110V, 60 Hz, 1-phase for steam condenser unit.
- J. Standards: Units shall conform to the applicable requirements of the following:
1. Underwriters Laboratories (UL).
 2. International Plumbing Code.
 3. NEC.
 4. ASME Code, Section VIII, Division 1 for unfired pressure vessels.
 5. ASME Code, Section I, Part PMB for power boilers.
- K. Options Required:
1. Water cooled steam condenser unit.
 2. Tubular leg stainless steel stand with shelf.
 3. Sterilmatic trays.
 4. Seismic tie-down kit.

2.2 LABORATORY STERILIZER (AUTOCLAVE): SMALL

- A. Manufacturers: Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
1. Beta Star Life Science Equipment of R-V Industries, Inc., <http://www.rvii.com>.
 2. Consolidated Sterilizer Systems, <http://www.consteril.com>.
 3. Getinge USA, Inc., <http://www.getingeusa.com>.
 4. Primus Sterilizer Co., Inc., <http://www.primus-sterilizer.com>.
 5. Steris Corporation, <http://www.steris.com>.
 6. Approved equal.
- B. Description: Small size steam-jacketed sterilizer designed for use in Laboratory and industrial applications.
- C. Chamber Size:
1. 20 inches x 20 inches x 38 inches (508 x 508 x 965 mm) nominal.
- D. Door/Mounting Configuration:
1. Single door, cabinet enclosed unit.
- E. Process Cycle Configuration:
1. Prevacuum: Prevacuum process shall be designed for fast, efficient sterilization of porous, heat- and moisture-stable materials, sterilization of liquids and media in borosilicate glass containers with vented closures, and decontamination of supplies after laboratory procedures. Prevacuum sterilizer shall be equipped with prevacuum, gravity, liquid, leak test and daily air removal test cycles.
- F. Steam Source:

1. Integral electric stainless steel clean steam generator supplied with purified water.

G. Product Characteristics:

1. Construction:

- a. Shell Assembly: Double wall, jacketed and insulated. Type 316L stainless steel welded sterilizer pressure vessel and type 304L or 316L stainless steel jacket. ASME rated at design operating pressure with allowance to relief valve setpoint - minimum 45 psig (310 kPa). Polished and passivated internal surfaces. Steam supply opening inside chamber to be shielded by a Type 316L stainless steel baffle. Chamber designed for positive sloped drainage with screen drain inlet to prevent debris for entering drain piping.
- b. Door Assembly: Vertical sliding door. Type 316L stainless steel, insulated with jacket. Door suspended by cable/pulley or chain/sprocket supports attached to counterweight or dual-spring assembly. Steam or compressed air activated recessed door gasket seal. Equipped with mechanical safety locking mechanism to prevent door opening when chamber pressure exceeds 2 psi (14 kPa). Provide door safety switch to prevent addition of steam to chamber unless door is closed and locked.
- c. Front Cabinet Panel: Type 304 or 316L stainless steel with No. 4 finish. Hinged or removable for full access to sterilizer piping and control systems.
- d. Side Panels: Sterilizer to be enclosed by Type 304 or 316L stainless steel removable side panels with No. 4 finish. Sterilizer sub-frame to be equipped with a synthetic rubber gasket to ensure tight fit between cabinet panels.
- e. Vacuum System: Liquid-ring vacuum pump to reduce chamber pressure during prevacuum and post-drying phase.
- f. Plumbing: All valves, fittings, and other plumbing components shall be non-proprietary. Custom manifolds or distribution systems shall not be installed. The piping system shall be designed such that all valve types used are from the same manufacturer for ease of maintenance. All utility piping connections shall terminate within the confines of the sterilizer and to be accessible from the front or access side of the unit. Provide ASME approved pressure relief valves rated for pressure vessels.
- g. Electrical: Electrical components such as switches, relays, and wiring systems shall be non-proprietary. Electrical design and installation shall conform to NEC requirements. Provide appropriate enclosure for components to protect against wet and moist environments.
- h. Floor Stand: Sterilizer to be equipped with a leveling height-adjustable floor stand manufactured of extruded aluminum structural members or welded stainless steel, or welded carbon steel with corrosion protective finish.

2. Control System:

- a. General: The sterilizer control system shall monitor, control, display, and record all process parameters. The control system shall include a PLC controller, touch-screen operator interface control panel, printer, audible alert, and emergency manual off (EMO) safety switch.
- b. Programmable Logic Controller (PLC) Controller: Non-proprietary controller to display, monitor, and control all sterilizer operations and functions. Allen-Bradley® MicroLogix™ control system or equal.
- c. Touch Screen Operator Interface Control Panel: Color active matrix (TFT) touch sensitive color interface screen. Allen-Bradley® PanelViewPlus™ or equal. Provide one screen on each side of pass-through units.

- d. Printer: Alphanumeric ink-on-paper dot-matrix impact or permanent thermal paper printer with take-up spool.
- e. Programming: All programming to be stored in non-volatile memory to retain programming during a power outage. Provide help menus/screens for programming and troubleshooting alarm conditions. Provide security features to prevent inadvertent or unauthorized process changes. Provide user programmable time-of-day utility startup/shutdown schedules for energy savings.
- f. RS-232 or equivalent communication protocol for downloading cycle information.
- g. USB or compact flash memory card slot for memory backup/restore and downloading cycle information.

H. Utilities:

1. Contractor to coordinate utility requirements with selected manufacturer's installation guide. The utility requirements below are intended to accommodate any of the specified units.
2. Electric Steam Generator Unit:
 - a. Drain: 1½ inch (38 mm) ODT.
 - b. Generator drain: ½ inch (12.7 mm) ODT.
 - c. Electrical Controls: 120V, 60 Hz.
 - d. Electric Steam Generator: 480 V, 60 Hz, 3-phase.
 - e. Electric Vacuum Pump: 480 V, 60 Hz, 3-phase.
 - f. Sterilizer feed water: Industrial cold water, 1 inch (25.4 mm) NPT, 30-50 psig (207-345 kPa) dynamic.
 - g. Compressed Air: ½ inch (38 mm) NPT, 80-100 psig (552-690 kPa). Refer to Accessories below, no building compressed air is available.
 - h. Steam generator feed water: Purified water, ½ inch (12.7 mm) NPT, 20-50 psig (138-345 kPa) dynamic.

I. Standards: Units shall conform to the applicable requirements of the following:

1. Underwriters Laboratories (UL).
2. International Plumbing Code.
3. NEC.
4. ASME Code, Section VIII, Division 1 for unfired pressure vessels.
5. ASME Code, Section I, Part PMB for power boilers.

J. Options Required:

1. Drain discharge cool down to limit discharge temperature into waste systems below 140°F.
2. Minimum 12-cycle capacity.
3. Seismic tie-down kit required to conform to local building codes.
4. Auto flush cycle for carbon steel steam generator with programmable timer/controls.
5. Power operated door.
6. Boiler Control and Safety Device (CSD-1) for secondary low water cut-off as required by local jurisdiction.
7. Clean Steam Piping: All steam-to-chamber piping components constructed of 300 series stainless steel.
8. Air compressor if required. Provide wall mounted powder coated steel or stainless steel shelf to support air compressor as well as anchorage and vibration isolation. Coordinate with Division 26 to provide electrical receptacle on dedicated circuit adjacent to compressor.

K. Accessories Required:

1. Rack and shelves.

2.3 LABORATORY GLASSWARE WASHER/DRYERS: BASE CABINET HEIGHT

- A. Manufacturers/Models: Products, as listed below, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers, listed in alphabetical order:
1. Labconco Corporation, <http://www.labconco.com>.
 - a. Model: Flaskscrubber
 2. Lancer USA, <http://www.lancer.com>.
 - a. Model: 815LX
 3. Miele Professional, <http://www.miele-pro.com>.
 - a. Model: G7883
 4. Steelco, <http://www.steelcospa.com>.
 - a. Model: Lab500SCL
 5. Approved equal.
- B. Description: Microprocessor-controlled laboratory glassware washer/dryer with purified water rinsing and with at least 9 automatic wash programs, capable of accepting optional inserts such as open baskets and spindles/injectors for open or injection cleaning of laboratory glassware on two rack levels.
- C. Size:
1. Minimum Chamber Dimensions: 20½ inches wide x 18½ inches high x 20 inches deep.
 2. Minimum Chamber Volume: 4.5 cubic feet.
 3. Maximum Overall Dimensions: 24¼ inches wide x 34½ inches high x 27½ inches deep.
- D. Door Configuration: Bottom-hinged, fold-down door with safety interlock.
- E. Product Characteristics:
1. Construction:
 - a. Insulated, fully cabinet-enclosed unit to allow for freestanding or under-counter installation. See Laboratory Furnishing drawings for location.
 - b. Chamber and door:
 - 1). Walls and ceiling, type 304 or 316 stainless steel
 - 2). Floor and door, type 304 or 316 stainless steel.
 - c. Exterior: Type 304 stainless steel.
 2. Control System: Control panel with LCD display to indicate cycle times, temperature, and error messages.
 3. Operation/ Performance:
 - a. Dual pump system with separate pumps for circulation and draining.
 - b. Rotating upper and lower wash arms.

- c. Circulation pump: rated at a minimum of 92 gpm.
- d. Minimum Heater rating: 2 kW.
- e. Wash water temperature: Unit shall be capable of attaining a wash temperature of 199°F (93°C).
- f. Final rinse temperature: Unit shall be capable of attaining a final purified water rinse temperature of 199°F (93°C).
- g. Easily-removable filter system to catch debris at bottom of the chamber.
- h. Drying system: Unit can use any of the following drying systems:
 - 1). Gravity-convected drying via an electrical heating element.
 - 2). Drying via an electrical heating element with an internal chamber circulation fan.
 - 3). Non-filtered fan-driven drying system.
- i. Detergents: Unit shall be capable of operating with both detergent and neutralizer. Dispensing shall either be manual or automatic.
- j. Noise Level: Unit shall operate at a noise level not exceeding 70 dBA.

F. Utility Requirements:

- 1. Contractor to coordinate utility requirements with selected manufacturer's installation guide. The utility requirements below are intended to be able to accommodate any of the specified units.
- 2. Hot water: Minimum incoming temperature: 120°F (49°C). Maximum incoming temperature 158°F (70°C). Input pressure 25 to 120 psig.
- 3. Cold water: Input pressure 29 to 87 psig.
- 4. DI rinse water: Input pressure 29 to 60 psig.
- 5. Electric: 208 V, 60 Hz, single-Phase, 12-40 A. Provide washer with cord and plug to match electrical receptacle.
- 6. Drain: Connect to sink tailpiece, standpipe, or into adjacent floor sink. Refer to drawings for details. Maximum flow rates: 10.5 gpm.

G. Listing:

- 1. Unit shall carry an ETL mark signifying certification to UL Standard 3101-1/61010-1 or CAN/CSA C22.2 No. 1010.1.

H. Accessories required:

- 1. Drain water cool-down kit.
- 2. Provide an initial set of detergent and neutralizer chemicals, sufficient for a minimum of 50 washes, per unit.
- 3. Glassware accessories:
 - a. Lower rack with a minimum of 19 spindles to provide for injection cleaning for narrow-neck glassware.

I. Utensil basket(s) of approximately 512 cubic inch capacity with lid/cover(s).

2.4 LABORATORY GLASSWARE WASHER/DRYERS: TALL

A. Manufacturers/Models: Products, as listed below, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers, listed in alphabetical order:

- 1. Getinge USA, Inc., <http://www.getingeusa.com>.

- a. Model: 8666
 2. Lancer USA, <http://www.lancer.com>.
 - a. Model: 1400 LXP
 3. Miele Professional, <http://www.miele-pro.com>.
 - a. Model: G7825
 4. Steelco, <http://steelcospa.com>.
 - a. Model: Lab 610
 5. Approved equal.
- B. Description: Microprocessor-controlled laboratory glassware washer/dryer with purified water rinsing and with at least 10 automatic wash programs, capable of accepting optional inserts such as open baskets and spindles/injectors for open or injection cleaning of laboratory glassware on multiple rack levels.
- C. Size:
1. Minimum Chamber Dimensions: 20 inches wide x 25½ inches high x 22½ inches deep.
 2. Minimum Chamber Volume: 8.06 cubic feet.
 3. Maximum Overall Dimensions: 55 inches wide x 82 inches high x 36 inches deep.
- D. Door Configuration:
1. Single door, freestanding.
- E. Steam Source:
1. Integral electric water heating. No building steam is available.
- F. Product Characteristics:
1. Construction:
 - a. Chamber and door: Type 316/316L stainless steel.
 - b. Exterior: Type 304 stainless steel.
 - c. RS-232 port to allow for connection to an external computer, printer, or chart recorder.
 - d. Insulated, fully cabinet-enclosed unit.
 - e. Door(s):
 - 1). Vertically-sliding door OR bottom-hinged drop-down door.
 - f. Provide door locking function to prevent door operation during cycle running.
 2. Control System: Control panel with multi-line digital display or touch-panel screen to indicate cycle times, temperature, and error messages.
 3. Operation/ Performance:
 - a. Rotating upper wash arm.
 - b. Minimum circulation pump rating: 159 gpm.
 - c. Minimum sump heater coil rating: 5 kW.

- d. Wash water temperature: Unit shall be capable of attaining a wash temperature of 203°F (95°C).
- e. Final rinse temperature: Unit shall be capable of attaining a final purified water rinse temperature of 203°F (95°C).
- f. Easily-removable filter system to catch debris at bottom of the chamber.
- g. Drying system:
 - 1). HEPA-filtered forced-air drying system which dries both the chamber and also dries glassware through the spindles/injectors. Unit shall be vented to the building exhaust system to remove vapors from the drying cycle.
 - 2). Drying temperature shall be adjustable up to at least 230°F (110°C).
- h. Detergents: Unit shall be capable of operating with both detergent and neutralizer. Dispensing of liquid detergent and neutralizer shall be automatic using dosing pumps to extract chemicals from containers located integral to the washer body. The unit shall incorporate level sensors for each chemical with low-level alarm readouts on the control panel.
- i. Noise Level: Unit shall operate at a noise level not exceeding 70dBA.

G. Utility Requirements:

- 1. Contractor to coordinate utility requirements with selected manufacturer's installation guide. The utility requirements below are intended to accommodate any of the specified units.
- 2. Hot water: Minimum incoming temperature: 122°F (50°C). Maximum incoming temperature 140°F (60°C). Input pressure 30 to 50 psig.
- 3. Cold water: Input pressure 30 to 50 psig.
- 4. Purified water: Input pressure 30 to 60 psig.
- 5. Exhaust Connection: 40-205 CFM with a maximum temperature of 240°F (116°C).
 - a. Note that exhaust air will be moisture-laden. Ductwork must be moisture-resistant and constructed to permit drainage of condensate.
 - b. Contractor to coordinate specific exhaust requirements with selected manufacturer's installation guide, as these vary substantially between manufacturers.
- 6. Drain: Unit will drain into adjacent floor sink. Maximum flow rate 50 gpm.
- 7. Electric:
 - a. Electric-heated units: 208V, 60 Hz, 3-phase, 27.5A-60A

H. Listing:

- 1. Unit shall carry an ETL mark signifying certification to UL Standard 61010-1 and/or CAN/CSA-C22.2 No. 61010-1.

I. Accessories required:

- 1. Drain water discharge cool-down package which mixes cold water with discharge water to assure that water is discharged at a temperature not exceeding 140°F (60°C).
- 2. Printer: Provide cycle printer.
- 3. Two additional chemical dosing pumps and level sensors.
- 4. Provide an initial set of detergent and neutralizer chemicals, sufficient for a minimum of 50 washes, per unit.

5. Provide an allowance of \$5,000 for glassware accessories. Final accessory selection to be coordinated with the Owner based on the final submitted unit, utilizing manufacturer's published list prices.
6. Transfer trolley/ loading cart
7. Seismic tie-down kit.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

- A. Inspection: Prior to installation of laboratory equipment, carefully inspect the installed work specified in other Sections and verify that all such work is complete to the point where this installation may properly commence.
- B. Discrepancies: In the event of discrepancy, immediately notify the Architect.

3.2 EXAMINATION

- A. Examine surfaces designated to receive work for conditions that would adversely affect the finished work. Repair or replace surfaces not meeting tolerances or quality requirements governing substrate construction prior to start of work.
- B. Verify that surfaces, prepared openings, or support structures are ready to receive work.
- C. Verify field measurements and opening dimensions are as instructed by manufacturer.
- D. Inspect and verify that the required utilities are available, in proper locations, prior to equipment installation.

3.3 WORK REQUIRED OF OTHER SECTIONS PRIOR TO INSTALLATION

- A. Install shutoff valves on service lines.
- B. Install fused disconnect switches (with lockout in OFF position) in electric supply lines near the equipment.
- C. Provide building service lines supplying specified pressures and flow rates.
- D. Provide illumination of service area, with provision of convenience outlet for maintenance.

3.4 INSTALLATION

- A. General:
 1. Install all equipment per manufacturer's recommendations and reviewed submittals.
 2. Properly align and position all equipment.
- B. Connection to Building Systems: See Laboratory Plumbing and Electrical drawings and Divisions 22 & 23 and 26 for final connections.

3.5 START UP AND TESTING

- A. Test, clean, and adjust equipment and apparatus installed to ensure performance meets specified requirements.
- B. Operate each unit and test full range of cycles over a continuous period. Record test data.

- C. Adjust and re-test any units not meeting requirements.

3.6 DEMONSTRATION AND INSTRUCTIONS

- A. Engage services of factory-qualified instructor to instruct and train Owner's operating and maintenance personnel in operation, service, and maintenance of equipment.
- B. Test equipment prior to demonstration. Ensure equipment, including specified accessories, is operational.
- C. Provide demonstration of equipment operation and instruction of Owner's personnel.
- D. Demonstrate operating capability of equipment and systems. Include control and safety features, and service and maintenance procedures.

3.7 CLEANING AND PROTECTION

- A. All equipment shall be protected before, during and after installation. Damage to material due to improper protection shall be cause for rejection.
- B. Packaging and debris and other waste resulting from installation of equipment will be removed.
- C. Repair or remove and replace defective Work as directed by the Architect upon completion of installation.
- D. Clean finished equipment, touch up as required and remove and refinish damaged or soiled areas.
- E. Prior to final acceptance by the customer, equipment that has become damaged will be repaired or replaced according to the terms of the warranty and any external soiled surfaces will be cleaned.

END OF SECTION 115350

SECTION 210500 – COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 RELATED WORK

- A. General Conditions
- B. Special Conditions
- C. Supplementary General Conditions
- D. Architectural, Structural, Civil, Electrical and Mechanical Drawings & Specifications

1.2 SCOPE OF WORK

- A. The work covered by the Mechanical and Plumbing Sections of the Specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of all mechanical and plumbing work required in the Contract Drawings.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified in this Section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.
- C. The Contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field. The Contractor shall advise the Architect of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions, and the inclusion of all considerations for existing conditions.

1.3 PLANS AND SPECIFICATIONS

- A. These Specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
- B. If departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted to the Architect for review. No departures shall be made without prior written acceptance of the Architect.
- C. The interrelation of the specifications, the drawings, and the schedules is generally as follows: The specifications determine the nature and setting of the materials, the drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.
- D. Should the drawings disagree in themselves or with the specifications, the contractor shall immediately notify the architect and shall perform and/or furnish the better quality or greater quantity of work or materials unless otherwise directed by the architect in writing. In case the specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on drawings govern scale measurements and large scale details govern small scale drawings. In case of

disagreement between specifications and drawings, see Division I of these specifications for clarifications.

- E. Items specifically mentioned in the specifications but not shown on the drawings and/or items shown on the drawings but not specifically mentioned in the specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

1.4 QUALITY ASSURANCE

- A. All work shall comply with the applicable rules of the following:
 - 1. 2018 International Building Code
 - 2. 2018 International Mechanical Code
 - 3. 2018 International Plumbing Code
 - 4. 2018 International Fire Code
 - 5. 2018 International Energy Conservation Code
 - 6. National Fire Protection Association Codes
 - 7. State Fire Marshall
 - 8. All applicable city, county, state, and federal rules, codes, and ordinances.
- B. In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. None of the terms or provisions of this specification shall be construed as waiving any rules, regulations, or requirements of these authorities. The codes shall govern in case of direct conflict between the codes and the Drawings.

1.5 SUPERVISION

- A. A competent foreman or superintendent, initially approved by the Architect, shall be assigned to the project to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect. Architect's authorized representative and/or owner's observer shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's representative. Recommendations made by the observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect.

1.6 GUARANTEE

- A. The Contractor shall guarantee all materials and workmanship for a period of two (2) years after the final acceptance of work.

1.7 UTILITIES

- A. The contract documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a

complete and operative system. The bid submitted by the Contractor shall include costs for all such utility company charges and/or fees.

1.8 BUILDING CONSTRUCTION AND LAYOUT OF WORK

- A. It shall be the responsibility of the Contractor to consult the architectural and engineering drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.
- B. The Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and duct in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.
- C. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect, and he reserves the right to make any reasonable changes in the locations indicated without additional cost.

1.9 SHOP DRAWINGS AND BROCHURES

- A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of work. At least two weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data.
- B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.
- C. Each Shop Drawing shall indicate in the lower right hand corner and each Brochure shall indicate on the front cover the following: the Title of the Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract Drawings and/or Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:
 - I. Shop Drawings: Drawings shall be drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by skilled technicians experienced in this type of

work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.

2. Brochures: Brochures shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space. Brochures not compiled in the manner described below shall be returned for resubmittal.
 3. Brochures submitted shall contain only information which is relevant to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.
- D. The submittal format shall follow the Specifications format with a submittal required for each section of Division 15. Each major category of equipment such as fans or pumps or air devices being submitted under a separate cover letter. The first submittal shall be accompanied by a three-ring hard back binder for the A/E to use in retaining copies of the submittals. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the A/E's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed manila index sheets also for the A/E's filing convenience.
- E. Submit six (6) copies of all Shop Drawings and Brochures for review and approval. One set will be retained by the Engineer, one set by the Architect for record purposes.
- F. Minimum size of submittal data shall be 8-1/2" x 11".
- G. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect reserved the right to require the Contractor to furnish items exactly as described in the Contract Documents.
- H. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they are not equal. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Architect based on the particular circumstances.

1.10 SUBSTITUTIONS

- A. The listing of product manufacturers, catalog numbers, etc., in the various sections of the specifications is intended to establish a standard of quality only, and is not intended to preclude open, competitive bidding. The Contractor may at his option submit substitute materials or methods which he feels are equal or superior to those specified. If the Contractor does submit alternate materials or methods, it shall be understood that the Contractor:
1. Has personally investigated the proposed substitute product and determined that it has all the same accessories and is equal or superior in all respects to the item specified.
 2. Will provide the same guarantee for the substitution that he would for that specified.
 3. Has coordinated the installation of the equipment which he proposes to substitute with all other trades especially in regard to electrical requirements and to operating weights trades

and includes the costs for any changes required for the work to be complete in all respects. The Contractor will prepare shop drawings where required by the Architect or where dimensions vary.

4. Waives any and all claims for additional costs related to the substitution.

1.11 SPARE PARTS DATA

- A. As soon as practicable after approval of materials and equipment, and, if possible, not later than one month prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the contract. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee specified.

1.12 RECORD DRAWINGS

- A. The Contractor shall keep a set of Drawings of the job, noting daily all changes made in the Drawings in connection with the final installation including exact dimensioned locations of all new and uncovered existing active and inactive utilities outside the building and shall turn over a clean, neatly marked set of sepia reproducible Drawings showing "as-built" work to the A/E for delivery to the Owner. All underground utilities and services and systems shall be accurately located by the Contractor and dimensioned on the "as-built" Drawings.

1.13 OPERATING AND MAINTENANCE MANUAL

- A. Prepare and submit to the Architect for delivery to the Owner an indexed manual with complete technical data for every piece of equipment and material installed under this contract.
 1. Complete fire suppression submittals as approved by Architect.
 2. Manufacturer's installation instruction brochures.
 3. Manufacturer's local representative and/or Distributor's name, address and phone number.
 4. Manufacturer's operating and maintenance brochures.
- B. This manual shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Sub-Contractors installing equipment represented in the brochure.
- C. Contents of the Manual shall be grouped in sections according to the various sections of Division 21 and shall be listed in a Table of Contents.

PART 2 PRODUCTS

2.1 STANDARDS FOR MATERIALS

- A. All materials, in general, shall conform to the requirements of all agencies of publications hereinbefore specified under the paragraph QUALITY ASSURANCE and shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this

listing, the Contractor may submit a statement from a nationally recognized testing agency indicating that the items have been tested in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

2.2 STANDARD PRODUCTS

- A. Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

2.3 MANUFACTURERS INSTRUCTIONS

- A. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor. If needed for proper installation, operation, or startup, the Contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Architect, he shall bear all costs arising in connection with the deficiencies.

2.4 RUST PREVENTION

- A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

2.5 STORAGE ON SITE

- A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is a suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

2.6 CAPACITIES

- A. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

2.7 NAMEPLATES

- A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

2.8 CONDITION OF MATERIAL AND APPURTENANCES

- A. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of substantial completion, shall be replaced by the Contractor without extra cost to Owner.

PART 3 EXECUTION

3.1 INSTALLATION OF SYSTEMS

- A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of system. No union will be required in welded lines or lines assembled with solder joint fittings, except at equipment items, machinery items, and other special pieces or apparatus. Companion flanges on lines at various items of equipment, machines and pieces of apparatus, shall serve as unions to permit removal of the particular items. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.

3.2 SPACE AND EQUIPMENT ARRANGEMENT

- A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of other equipment.
- B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly protected against damage.

3.3 PRECEDENCE OF WORK

- A. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades.

3.4 EXCAVATION AND BACKFILL

- A. The Contractor shall perform all excavation of every description required in the execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the drawings, or as required. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and causing cave-ins. Excavated materials not suitable for backfill shall be removed or stored as directed. Such grading shall be done as is necessary to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheeting and shoring shall be provided as required for the protection of the work and the safety of personnel.
- B. Trenches shall be of the necessary width and depth to provide for proper laying of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on firm and undisturbed soil. Bell holes, of a size to permit proper grading, shall be provided as required. Over-depth excavations shall be backfilled to proper level with sand. When rock or other soil not suitable for bedding the pipe is encountered, it shall be removed to a depth of not less than 1' below grade, and backfilled with sand to grade, to provide a suitable bed for pipe. Existing underground piping shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired to the Architect's satisfaction, at the Contractor's expense.
- C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with a minimum 6" sand cover over piping then backfilled with material (free from large earth clods, rocks, and/or foreign materials), laid in 6" layers, compacted to 90 percent of maximum

dry density as determined by ASTM D698 (compaction shall be to 95 percent below structures, including sidewalks and roadways).

- D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for as distance of not less than 10' from the above features, as soon as possible. All damage resulting from flooding due to open trenches shall be paid for by the Contractor.
- E. Where excavation requires, existing walks, street, drives, or other existing pavement shall be cut to install new lines and to make new connections to existing lines. The size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces, and shall be level with them.

3.5 CUTTING AND PATCHING

- A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the observation of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written direction of the Architect.
- B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by the cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.
- C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.6 HOISTING, SCAFFOLDING, AND TRANSPORTATION

- A. The Contractor shall provide his own hoisting facilities to set his materials and equipment in place in the building, as indicated on drawings and for subsequent cleaning, testing, and adjusting.
- B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.7 CLEANING

- A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.
- B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

3.8 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

- A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Mechanical Drawings or specified in the Mechanical Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items' proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and

electrically connected as specified in Division 16 - Electrical. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in the Electrical Specifications and shown on the Electrical Drawings.

END OF SECTION

SECTION 21 0523 - VALVES FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Gate Valves
- B. Ball Valves
- C. Check Valves
- D. Butterfly Valves

1.02 RELATED WORK

- A. Section 210500 – Common Work Results For Fire Suppression
- B. Section 211313 - Wet Pipe Sprinkler Systems

1.03 SHOP DRAWINGS

- A. Submit product data in accordance with Section 210500 Common Work results For Fire Suppression.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Valves as manufactured by KITZ, Nibco, Crane, Apollo, Watts or approved equal are acceptable provided they meet or exceed these specifications.
- B. Provide valve types of same manufacturer throughout where possible.
- C. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
- D. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be of same make for all these services.

2.02 VALVE CONNECTIONS

- A. Provide valves suitable for connection to adjoining piping as specified for pipe joints. Use pipe size valves unless otherwise indicated.
- B. Provide threaded valves for pipe sizes 2 inches and smaller.
- C. Provide flanged valves for pipe sizes 2 1/2 inches and larger.
- D. Solder or screw to solder adaptors for copper tubing.

- E. Use valve body suitable for mechanical coupling jointed piping.
- F. Provide butterfly valves with full tapped lug bodies.

2.03 GATE VALVES

- A. Select valves, equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves must be machined for accurate fit.
- B. Comply with the following standards:

Cast Iron Valves:	MSS SP - 70
Bronze Valves:	MSS SP - 80
- C. Threaded ends 2" and smaller: Class 125, bronze body, union bonnet, rising stem, solid wedge: Kitz #42, Nibco T-124/134, Crane 431UB or equal.
- D. Solder ends 2" and smaller: Class 150, bronze body, union bonnet, rising stem, solid wedge: Kitz #43, Nibco S-134 or equal.
- E. Flanged ends 2-1/2" and larger: Class 125 iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Kitz #72, Nibco F617-0, Crane 465-1/2 or equal.

2.04 BALL VALVES

- A. Select with full port opening, blow out proof stem, hard chrome plated forged brass vented ball, adjustable packaging nut, rated not less than 600# W.O.G., 150 W.S.P.
- B. Comply with the following standards:

Ball Valves:	MSS SP - 110
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- C. Threaded ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #68, Nibco T-585-70, Apollo 77-100 Series, Watts B-6080 or equal.
- D. Solder ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #68, Nibco T-585-70, Apollo 77-200 Series, Watts B-6081 or equal.

2.05 BUTTERFLY VALVES

- A. Where butterfly valves are used as shut-off for termination, or equipment removal or repair, select ductile iron lug type valves, bi-directional, dead-end service rated to the full working pressure of the valve. Provide gear operators on butterfly valves 8" and larger. Valve bodies to have extended necks to provide for 2-1/2" insulation as needed. Butterfly valves 12 inch and smaller rated to 200 psi, 14 inch and larger to 150 psi.
- B. Comply with the following standards:

Butterfly Valves:	MSS SP - 67
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- C. Lug type 2" and larger: Ductile iron body, lever operated, 10-position throttling handle 2-6 inch, 8 inch and larger gear operated, bronze disc, type 400 Series stainless steel stem, EPDM seat. Butterfly valves 12 inch and smaller rated to 200 psi, 14 inch and larger 150 psi.
- D. Manufacturer subject to compliance with requirements, provide butterfly valves with one of the following: Kitz #6122E (Lug type), Milwaukee, ML233E (Lug), Nibco LD2000 (Lug) or equal.

2.06 SWING CHECK VALVES

- A. Comply with the following standards for design, workmanship, material and testing:

Bronze Valves:	MSS SP - 80
Cast Iron Valves:	MSS SP - 71
- B. Construct valves of pressure casting free of any impregnating materials
- C. Threaded ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, Teflon disc: Kitz #22T, Nibco T-413Y, Crane 141 or equal.
- D. Soldered ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, Teflon disc: Kitz #23T, Nibco T-433Y, Crane 37 or equal.
- E. Flanged ends 2-1/2" and larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Kitz #78, Nibco F918-B, Crane 373 or equal.

2.07 VALVE FEATURES

- A. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.
- B. Flanged valve ends comply with ANSI B16.1 (cast iron), ANSI B16.24 (bronze).
- C. Threaded valve ends comply with ANSI B2.1.
- D. Solder Joint valve ends complying with ANSI B16.18.
- E. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials; of standard alloy recognized in valve manufacturing that resist de-zincification.
- F. Butterfly valve designed for flow regulation and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220 psi. No leakage permitted under test.

2.08 VALVE OPERATORS

- A. Provide suitable handwheels for gate, globe and butterfly valves.
- B. For butterfly valves provide gear operators for sizes 8 inches and larger. For smaller sizes provide lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock nut and memory stop for throttling service.
- C. Provide valves located more than 7 feet from floor in equipment room areas with chain wheel operators. Extend chains to about 5 feet above floor and hook to clips arranged to clear walking aisles.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install gate valves for shut-off and isolating service, to isolate equipment, part of systems, or vertical risers.
- C. Install check valves in horizontal position with pin horizontally perpendicular to center line of pipe. Install for proper direction of flow. Installations on any vertical piping must be up flow only.
- D. Provide U.L. indicator posts for gate valves used in fire protection service where required.
- E. Use U.L. approved butterfly valves in fire protection systems for post indicator valves if approved.
- F. All valves shall be located so that the bonnets can be removed.
- G. Where valves are installed concealed in pipe chases provide Zurn Z-1460-4 or approved equal access doors with concealed hinge and key operated locks. Door shall be large enough to service valves and shall be installed flush with finished walls.
- H. Provide cast iron U.L. listed approved indicator posts on post indicator valves. Stockham G 951 or approved equal.
- I. Provide bass tag for each valve labeling the fluid in the pipe, the area served, and the normal operating position.

END OF SECTION

SECTION 210529 - SUPPORTS, ANCHORS AND SLEEVES FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe Hangers and Supports

1.2 RELATED WORK

- A. Section 210500 – Common Work Results For Fire Suppression
- B. Section 211313 - Wet Pipe Sprinkler System

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with Section 210500 Common Work Results For Fire Suppression.

1.4 REFERENCES

- A. Automatic Sprinkler Pipe Supports: NFPA No. 13, Standard for the Installation of Sprinkler Systems, FM approved.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall be as manufactured by Grinnell, Elcen, Fee and Mason, Unistrut or approved equal.

2.2 INSERTS

- A. Malleable iron case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
- B. Size inserts to suit threaded hanger rods.

2.3 PIPE HANGERS AND SUPPORTS

- A. Hangers: Pipe sizes 1/2 inch to 1-1/2 inch: adjustable wrought steel ring.
- B. Hangers: Pipe sizes 2 inches to 4 inches: adjustable wrought steel clevis.
- C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D. Vertical Support: Steel riser clamp.
- E. Steel Beam Clamps: Elcen Figure 33, Type 3 or approved equal.
- F. Expansion Anchors: Phillips Red Head or approved equal.
- G. Design hangers to impede disengagement by movement of supported pipe.

2.4 HANGER RODS

- A. Provide cadmium plated steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.5 SLEEVES

- A. Pipes through Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with galvanized steel pipe.
- B. Size large enough to allow for movement due to expansion and to provide for continuous installation.

PART 3 EXECUTION

3.1 INSERTS

- A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch or ducts over 60 inches wide.
- C. Where concrete slabs form finished ceiling finish inserts, flush with slab surface.

3.2 PIPE HANGERS AND SUPPORTS

- A. All structures and appurtenances employed for the purpose of supporting the pipe and guiding it properly shall be carefully fabricated in such a manner as to preserve the true grade of the pipe without subjecting either the pipe or the supporting and guidance members to any undue strain.
- B. Support horizontal piping as follows:
- C. Space hangers and furnish rods as follows:

Nominal Pipe Size (in.)	Span (ft.)		Hanger Rod Diameter (in.)
	Steel	Copper	
1/2	5	5	3/8
3/4	6	6	3/8
1	7	6	3/8
1-1/2	9	8	3/8
2	10	9	3/8
3	10	10	1/2
4	10	10	5/8

- D. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.
- E. Place a hanger within one foot of each horizontal elbow.
- F. Use hangers which are vertically adjustable 1-1/2 inch maximum after piping is erected.
- G. Support piping at each change or direction, at ends of branches, at base and top of riser pipes and drops, and wherever necessary to prevent sag, bending or vibration, in addition to above-listed hanger spacing.

- H. Support vertical piping at every floor.

3.3 PRIMING

- A. Prime coat non-galvanized steel hangers and supports.

3.4 SLEEVES

- A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
- B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.
- C. Where piping passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.
- D. Install chrome plated escutcheons where piping passes through finished surfaces.
- E. Provide pipe sleeves for all piping.
- F. Size pipe sleeves to permit placing pipe.
- G. Sleeves for pipes through floor slabs standard weight galvanized steel pipe with top of sleeve projecting 2 inches above finished floor. For waterproof sleeves.
- H. Sleeves for pipe through walls standard weight galvanized steel pipe or 18-gauge galvanized sheet metal with ends flush with wall surface.
- I. Seal pipes passing through walls or slabs. Use mastic or oakum seal in the annular space in non-fire-rated walls; use Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal in the annular space in fire-rated walls or other envelopes.
- J. Seal exposed pipe passing through floor slabs with Dow- corning 3-6548 silicone RTV foam firestop sealant or equal and point with caulking compound. Strike off flush at top of sleeve.
- K. Sleeves penetrating exterior walls below grade shall be standard weight, black steel pipe with 1/4" thick steel plate secured to the pipe with a continuous fillet weld. The plate shall be located in the middle of the wall and shall be 4" wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. The pipe passing through the sleeve shall be centered within the sleeve and the annulus opening sealed with "Link Seal" casing seals manufactured by Thunderline Corporation, Wayne, Michigan. Series 300 for pipe sizes 1/2" through 10" and series 400 or 500 for larger pipe sizes or equal.
- L. All piping shall be installed with due regard to expansion and contraction. Type of hanger, methods of support, location of supports, etc., shall be governed in part by this consideration.

END OF SECTION

SECTION 211313 - WET PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. All work performed under this Section of the Specifications shall be in strict accordance with the provisions of the General Conditions and Requirements, and Section 210500 Common Work Results For Fire Suppression.

1.2 WORK INCLUDED

- A. The design and installation of a complete wet pipe automatic sprinkler system including exterior and interior water piping, sprinkler heads, valves, hangers and supports, sleeves, Fire Department connections and accessories.
- B. Verification of all design criteria stated within these documents (including but not limited to Hazard Occupancy Classification, Design Density and Availability of Water) prior to bidding. If a conflict is found between the stated design criteria and any governing agency, the contractor shall notify the Architect prior to bidding.

1.3 RELATED WORK

- A. Section 210500 – Common Work Results For Fire Suppression
- B. Section 210523 – Valves For Fire Suppression
- C. Section 210529 – Supports, Anchors and Sleeves For Fire Suppression

1.4 REFERENCE STANDARDS

- A. NFPA No. 13: Sprinkler Systems
- B. NFPA No. 24: Fire Department Connections
- C. Local Fire Code and State Fire Marshal Requirements

1.5 QUALITY ASSURANCE

- A. Sprinkler equipment, design and installation shall meet the requirements, recommendations of local authority having jurisdiction and the Owner's Insurance Underwriters.
- B. The design, equipment furnished and installation shall meet the requirements of NFPA No. 13, "Standard for the Installation of Sprinkler Systems."
- C. Systems shall be tested in accordance with NFPA-13. Test shall be witnessed by Architect and approved in writing prior to activation.
- D. The system shall be designed and installed by a firm regularly engaged in the design and installation of automatic fire protection systems, in accordance with the requirements of the National Fire Protection Association, or by an authorized Agent of such firm. Evidence to support the above requirements may be requested, and any proposed installer who cannot show suitable experience will be rejected.

- E. Standard Products: Materials and equipment shall be standard products of the manufacturer's latest design, and suitable to perform the functions intended. The name of the manufacturer, and the serial numbers, shall appear on all major components and shall bear the UL or FM label or marking. Equipment added to an existing system shall function in the same manner as similar components of the existing system.
- F. Conformance to Agency Standards: Submit evidence of conformance of the entire system to the requirements of NFPA 13 standards, and of the Arizona State Fire Marshal and the Authorities having Jurisdiction. Required changes to meet code, insurance or jurisdictional authority requirements are to be made by the sprinkler contractor at no additional cost to the Owner.

1.6 SUBMITTALS

- A. Submit shop drawings in accordance with Section 210500.
- B. Fire sprinkler system shop drawings shall be submitted to the Architect prior to any submittals to any AHJ. The Architect's comments shall be incorporated into revised plans as required, shall be revised and resubmitted to the Architect for verification of compliance with design intent, and after Architect approval shall be submitted to the AHJ. If the AHJ makes revisions, the plans shall again be submitted to the Architect for review prior to resubmittal to the AHJ. No installation shall proceed without plans approved by both the Architect and the AHJ.
- C. The shop drawings shall include detailed plans of sprinkler systems, calculations, sections and plot plan indicating the locations of underground supply connections, control valves, fire department connections, and other equipment to be used. Submit manufacturer's data on materials and equipment.

1.7 SYSTEM DESCRIPTION

- A. System to provide full coverage for the entire building.
- B. Provide a complete hydraulically designed system to meet NFPA 13 standards and occupancy requirements and hazard classifications as indicated on the drawings. Contractor shall be responsible for pressure and flow verification with the jurisdiction having authority prior to final design and system installation.
- C. The location of equipment and piping mains shall conform as closely as possible to that shown on the plans. Contractor is advised, however, that the information shown on the plans is intended to indicate the general intent and scope of the project for bidding purposes only. Contractor shall use the drawings for reference only during bidding, and shall be fully responsible for the actual final arrangement of piping, head locations, and spacing and other system details as required to conform to the requirements of authorities having jurisdiction. Required changes to meet code, insurance, or jurisdictional authority requirements are to be made by the Sprinkler Contractor at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Automatic Sprinkler, ITT Grinnell, Viking, Central or approved equal meeting these specifications are acceptable.
- B. All materials and equipment used in the installation of the fire protection system shall be listed as approved by the underwriters Laboratories, Inc., list of inspected Fire Protection Equipment and

Materials, and the Factory Mutual Testing Laboratories list of approved equipment. Fire protection devices and devices involving fire hazard shall be the latest design of the manufacturer.

2.2 SPRINKLER PIPING AND PIPE FITTINGS

A. Piping Systems:

1. Exterior Water Pipe: Pipe shall be ductile iron pressure pipe with ductile iron fittings and mechanical joint connections.
2. Interior Water Pipe: Piping, fitting, valves, and installation shall be as specified in NFPA 13.

2.3 SPRINKLER HEADS

- A. Unless otherwise specified or indicated on the drawings, sprinkler heads shall be regular automatic closed-type except that sprinkler heads to be installed in the vicinity of heating equipment and lights, shall be of the temperature rating required for such locations by National Fire Protection Association Standard No. 13.
- B. In finished or suspended ceiling areas, provide recessed type sprinklers to Gem Model FR948 with chrome plated finish and white escutcheon.
- C. In the Mechanical rooms, or exposed areas, provide upright sprinklers equal to Gem Model F950 in bronze finish.
- D. For sidewall application, provide sidewall sprinklers equal to Gem F950/Q46 type with chrome plated finish and escutcheon.

2.4 VALVES

- A. Provide gate valves, butterfly valves and check valves in accordance with Section 210523.
- B. The fire riser shall have a main indicating butterfly valve for shut off control in accordance with Section 210523.

2.5 ALARM DEVICES

- A. Riser water flow indicator switch shall be U.L. listed. Potter Model VSR-A or approved equal. Flow switch shall have two sets of contacts.
- B. Sprinkler system control valves, riser butterfly valve indicator, post valves and other valves required by NFPA- 13 or the local authority shall be furnished with a tamper switch. Tamper switch shall have two sets of contacts.
- C. Furnish and install a 6" electric alarm equal to Central Sprinkler Corp.

2.6 SIAMESE FIRE DEPARTMENT CONNECTION

- A. Provide two-way standard siamese fire department connection with chrome plated finish, local Fire Department thread, dust caps and chains, 3/4 inch automatic drip (connected to drain) marked "Automatic Sprinkler -Fire Department Connection".

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate the work of this Section with other affected work. This installation shall not cause interference with that of other trades.
- B. All openings for piping should be anticipated and indicated on the approved and accepted shop drawings. Any additional cutting of openings must have the written approval of the Architect/Engineer.

3.2 INSTALLATION

- A. Locate the fire department connection with sufficient clearance from walls or obstructions to allow full swing of fire department wrench handle.
- B. Place pipe runs to avoid obstruction and interference with other work. Run piping in concealed spaces above finished ceilings. In exposed areas, piping will be kept at a minimum distance from the ceiling.
- C. Piping shall allow for drainage at the riser. Trapped areas, if unavoidable, shall be provided with drains as required by NFPA 13.
- D. Extend discharge of inspectors test valve, alarm valve and drains to curb or other point to avoid discharge across walks or into occupied areas.
- E. Provide signs as required by Code to identify all items.
- F. The fire protection system shall be tied into the building fire alarm system.
- G. Support sprinkler piping from building structure with hangers and supports in accordance with NFPA Standard No. 13. Space hangers per NFPA No. 13. Furnish and install intermediate steel supports as required. Attach hangers or rods to concrete roof and floor structures with devices compatible with the structural types as approved by architect. Weight of piping and valves must be supported in a manner which does not impose eccentric loads on structural elements.
- H. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings.
- I. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions, shall be made without increase in cost to the Owner or the Architect. Pay careful attention to NFPA beam rules in laying out heads. Ducts, conduit bundles and other building items fall under the beam rules.
- J. Heads shall be located in a symmetrical pattern related to ceiling features such as beams, light fixtures, diffusers, etc., and where applicable, heads shall be located symmetrical with the grid ceiling. Heads shall be centered (both directions) in a 2 x 2 ceiling tile or arranged in a manner acceptable to the Architect prior to installation. Heads protruding below escutcheon are not acceptable. Heads shall be semi-recessed. Carefully coordinate with other trades to avoid conflict with ducts, conduit, lights and structural items.
- K. The Contractor shall provide spare heads equal to one percent of the total number of heads installed under the Contract, but not less than 10.

- L. The heads shall be packed in a suitable sprinkler cabinet and shall be representative of, and in proportion to, the number of each type and temperature rating of heads installed.
- M. In addition to the spare heads, the Contractor shall provide not less than one special sprinkler head-wrench for each type of head. The cabinet shall be located where directed by the Architect, or on the wall near sprinkler valve.
- N. Run piping above furred ceiling and in joists to avoid obstructions. Coordinate with other trades to insure there are no conflicts or interferences.
- O. Protect sprinkler heads in exposed areas against mechanical injury with standard guards.
- P. Locate outside alarms on the wall of the building above the Fire Department connection.
- Q. Fire sprinkler subcontractor shall be responsible for defining the required electrical connection to the Fire Alarm Panel with the electrical subcontractor. Electrical subcontractor will perform electrical installation of conduit and wire. Fire sprinkler subcontractor shall be responsible for coordinating work with the electrical subcontractor.
- R. The service line entering the building shall have all joints strapped flange to flange for kickout protection. The building structure shall not be used as a kick block and full clearance through the building wall or floor shall be maintained.

3.3 ACCEPTANCE AND TESTING

- A. During the fabrication and assembly of all piping, prior to testing and before connection is made to any equipment, the piping shall be blown with dry, oil-free compressed air to clear the pipe of dirt, welding slag and other materials which may be harmful to sprinkler heads and other equipment.
- B. Prior to connecting to the overhead sprinkler piping, the underground main shall be flushed in the presence of the Architect and a representative of the authorities having jurisdiction and meet with their approval.
- C. After completion of the installation, the entire system shall be tested by the contractor for acceptance by the authorities having jurisdiction.
- D. The contractor shall provide and complete all forms required for testing and acceptance of the system. Copies of these documents shall be provided to the authorities having jurisdiction, the owner and the Architect, in accordance with Section 210500 Common Work Results For Fire Suppression.

END OF SECTION

SECTION 220500 – COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 RELATED WORK

- A. General Conditions
- B. Special Conditions
- C. Supplementary General Conditions
- D. Architectural, Structural, Civil, Electrical and Mechanical Drawings & Specifications

1.2 SCOPE OF WORK

- A. The work covered by the Mechanical and Plumbing Sections of the Specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of all mechanical and plumbing work required in the Contract Drawings.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified in this Section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.
- C. The Contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field. The Contractor shall advise the Architect of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions, and the inclusion of all considerations for existing conditions.

1.3 PLANS AND SPECIFICATIONS

- A. These Specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
- B. If departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Architect for review. No departures shall be made without prior written acceptance of the Architect.
- C. The interrelation of the specifications, the drawings, and the schedules is generally as follows: The specifications determine the nature and setting of the materials, the drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.
- D. Should the drawings disagree in themselves or with the specifications, the contractor shall immediately notify the architect and shall perform and/or furnish the better quality or greater quantity of work or materials unless otherwise directed by the architect in writing. In case the specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on drawings govern scale measurements and large scale details govern small scale drawings. In case of

disagreement between specifications and drawings, see Division I of these specifications for clarifications.

- E. Items specifically mentioned in the specifications but not shown on the drawings and/or items shown on the drawings but not specifically mentioned in the specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

1.4 QUALITY ASSURANCE

- A. All work shall comply with the applicable rules of the following:
 - 1. 2018 International Building Code
 - 2. 2018 International Mechanical Code
 - 3. 2018 International Plumbing Code
 - 4. 2018 International Fire Code
 - 5. 2018 International Energy Conservation Code
 - 6. National Fire Protection Association Codes
 - 7. All applicable city, county, state, and federal rules, codes, and ordinances.
- B. In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. None of the terms or provisions of this specification shall be construed as waiving any rules, regulations, or requirements of these authorities. The codes shall govern in case of direct conflict between the codes and the Drawings.

1.5 SUPERVISION

- A. A competent foreman or superintendent, initially approved by the Architect, shall be assigned to the project to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect. Architect's authorized representative and/or owner's observer shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's representative. Recommendations made by the observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect.

1.6 GUARANTEE

- A. The Contractor shall guarantee all materials and workmanship for a period of two (2) years after the final acceptance of work.

1.7 UTILITIES

- A. The contract documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such utility company charges and/or fees.

1.8 BUILDING CONSTRUCTION AND LAYOUT OF WORK

- A. It shall be the responsibility of the Contractor to consult the architectural and engineering drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.
- B. The Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and duct in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.
- C. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect, and he reserves the right to make any reasonable changes in the locations indicated without additional cost.

1.9 SHOP DRAWINGS AND BROCHURES

- A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of work. At least two weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data.
- B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.
- C. Each Shop Drawing shall indicate in the lower right hand corner and each Brochure shall indicate on the front cover the following: the Title of the Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract Drawings and/or Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:
 - I. Shop Drawings: Drawings shall be drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by skilled technicians experienced in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.

2. Brochures: Brochures shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space. Brochures not compiled in the manner described below shall be returned for resubmittal.
 3. Brochures submitted shall contain only information which is relevant to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.
- D. The submittal format shall follow the Specifications format with a submittal required for each section of Division 15. Each major category of equipment such as fans or pumps or air devices being submitted under a separate cover letter. The first submittal shall be accompanied by a three-ring hard back binder for the A/E to use in retaining copies of the submittals. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the A/E's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed manila index sheets also for the A/E's filing convenience.
- E. Submit six (6) copies of all Shop Drawings and Brochures for review and approval. One set will be retained by the Engineer, one set by the Architect for record purposes.
- F. Minimum size of submittal data shall be 8-1/2" x 11".
- G. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect reserved the right to require the Contractor to furnish items exactly as described in the Contract Documents.
- H. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they are not equal. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Architect based on the particular circumstances.

1.10 SUBSTITUTIONS

- A. The listing of product manufacturers, catalog numbers, etc., in the various sections of the specifications is intended to establish a standard of quality only, and is not intended to preclude open, competitive bidding. The Contractor may at his option submit substitute materials or methods which he feels are equal or superior to those specified. If the Contractor does submit alternate materials or methods, it shall be understood that the Contractor:
1. Has personally investigated the proposed substitute product and determined that it has all the same accessories and is equal or superior in all respects to the item specified.
 2. Will provide the same guarantee for the substitution that he would for that specified.
 3. Has coordinated the installation of the equipment which he proposes to substitute with all other trades especially in regard to electrical requirements and to operating weights trades and includes the costs for any changes required for the work to be complete in all respects. The Contractor will prepare shop drawings where required by the Architect or where dimensions vary.

4. Waives any and all claims for additional costs related to the substitution.

1.11 SPARE PARTS DATA

- A. As soon as practicable after approval of materials and equipment, and, if possible, not later than one month prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the contract. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee specified.

1.12 RECORD DRAWINGS

- A. The Contractor shall keep a set of Drawings of the job, noting daily all changes made in the Drawings in connection with the final installation including exact dimensioned locations of all new and uncovered existing active and inactive utilities outside the building and shall turn over a clean, neatly marked set of sepia reproducible Drawings showing "as-built" work to the A/E for delivery to the Owner. All underground utilities and services and systems shall be accurately located by the Contractor and dimensioned on the "as-built" Drawings.

1.13 OPERATING AND MAINTENANCE MANUAL

- A. Prepare and submit to the Architect for delivery to the Owner an indexed manual with complete technical data for every piece of equipment and material installed under this contract.
 1. Complete submittals as approved by Architect.
 2. Manufacturer's installation instruction brochures.
 3. Manufacturer's local representative and/or Distributor's name, address and phone number.
 4. Manufacturer's operating and maintenance brochures.
 5. Replacement part number listings and/or descriptions.
 6. Lubrication materials required, with instructions.
 7. Valve tag list.
- B. This manual shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Sub-Contractors installing equipment represented in the brochure.
- C. Contents of the Manual shall be grouped in sections according to the various sections of the specifications and shall be listed in a Table of Contents.

PART 2 PRODUCTS

2.1 STANDARDS FOR MATERIALS

- A. All materials, in general, shall conform to the requirements of all agencies of publications hereinbefore specified under the paragraph QUALITY ASSURANCE and shall be listed, inspected,

and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized testing agency indicating that the items have been tested in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

2.2 STANDARD PRODUCTS

- A. Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

2.3 MANUFACTURERS INSTRUCTIONS

- A. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor. If needed for proper installation, operation, or startup, the Contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Architect, he shall bear all costs arising in connection with the deficiencies.

2.4 RUST PREVENTION

- A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

2.5 STORAGE ON SITE

- A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is a suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

2.6 CAPACITIES

- A. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

2.7 NAMEPLATES

- A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

2.8 CONDITION OF MATERIAL AND APPURTENANCES

- A. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage

on premises, while being erected and installed, and while being tested, until time of substantial completion, shall be replaced by the Contractor without extra cost to Owner.

PART 3 EXECUTION

3.1 INSTALLATION OF SYSTEMS

- A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of system. No union will be required in welded lines or lines assembled with solder joint fittings, except at equipment items, machinery items, and other special pieces or apparatus. Companion flanges on lines at various items of equipment, machines and pieces of apparatus, shall serve as unions to permit removal of the particular items. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.

3.2 SPACE AND EQUIPMENT ARRANGEMENT

- A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of other equipment.
- B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly protected against damage.

3.3 PRECEDENCE OF WORK

- A. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades.

3.4 EXCAVATION AND BACKFILL

- A. The Contractor shall perform all excavation of every description required in the execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the drawings, or as required. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and causing cave-ins. Excavated materials not suitable for backfill shall be removed or stored as directed. Such grading shall be done as is necessary to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheeting and shoring shall be provided as required for the protection of the work and the safety of personnel.
- B. Trenches shall be of the necessary width and depth to provide for proper laying of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on firm and undisturbed soil. Bell holes, of a size to permit proper grading, shall be provided as required. Over-depth excavations shall be backfilled to proper level with sand. When rock or other soil not suitable for bedding the pipe is encountered, it shall be removed to a depth of not less than 1' below grade, and backfilled with sand to grade, to provide a suitable bed for pipe. Existing underground piping shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired to the Architect's satisfaction, at the Contractor's expense.
- C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with a minimum 6" sand cover over piping then backfilled with material (free from large

earth clods, rocks, and/or foreign materials), laid in 6" layers, compacted to 90 percent of maximum dry density as determined by ASTM D698 (compaction shall be to 95 percent below structures, including sidewalks and roadways).

- D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for as distance of not less than 10' from the above features, as soon as possible. All damage resulting from flooding due to open trenches shall be paid for by the Contractor.
- E. Where excavation requires, existing walks, street, drives, or other existing pavement shall be cut to install new lines and to make new connections to existing lines. The size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces, and shall be level with them.

3.5 CUTTING AND PATCHING

- A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the observation of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written direction of the Architect.
- B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by the cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.
- C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.6 HOISTING, SCAFFOLDING, AND TRANSPORTATION

- A. The Contractor shall provide his own hoisting facilities to set his materials and equipment in place in the building, as indicated on drawings and for subsequent cleaning, testing, and adjusting.
- B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.7 CLEANING

- A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.
- B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

3.8 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

- A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Mechanical Drawings or specified in the Mechanical Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items' proper operations. These

motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in Division 16 - Electrical. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in the Electrical Specifications and shown on the Electrical Drawings.

END OF SECTION

SECTION 22 0523 - VALVES FOR PLUMBING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Gate Valves
- B. Globe Valves
- C. Ball Valves
- D. Check Valves
- E. Butterfly Valves
- F. Balancing Valves

1.02 RELATED WORK

- A. Section 220500 – Common Work Results For Plumbing
- B. Section 221116 – Plumbing Piping

1.03 SHOP DRAWINGS

- A. Submit product data in accordance with Section 220500 Common Work Results For Plumbing.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Valves as manufactured by KITZ, Nibco, Crane, Apollo, Watts or approved equal are acceptable provided they meet or exceed these specifications.
- B. Provide valve types of same manufacturer throughout where possible.
- C. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
- D. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be of same make for all these services.

2.02 VALVE CONNECTIONS

- A. Provide valves suitable for connection to adjoining piping as specified for pipe joints. Use pipe size valves unless otherwise indicated.
- B. Provide threaded valves for pipe sizes 2 inches and smaller.
- C. Provide flanged valves for pipe sizes 2 1/2 inches and larger.

- D. Solder or screw to solder adaptors for copper tubing.
- E. Use valve body suitable for mechanical coupling jointed piping.
- F. Provide butterfly valves with full tapped lug bodies.

2.03 GATE VALVES

- A. Select valves, equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves must be machined for accurate fit.
- B. Comply with the following standards:
 - Cast Iron Valves: MSS SP - 70
 - Bronze Valves: MSS SP - 80
- C. Threaded ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge: Kitz #44, Nibco T-111, Crane 428 or equal. (Non-rising gate valves may be used where headroom prevents full extension of rising stems: Kitz #40, Nibco T-113, Crane 438 or equal)
- D. Solder ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge: Kitz #44, Nibco S-111, Crane 428 or equal. (Non-rising stem gate valves may be used where headroom prevents full extension of rising stems: Kitz #41, Nibco S-113, Crane 438 or equal)
- E. Flanged ends 2" and larger: Class 125 iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Kitz #72, Nibco F617-0, Crane 465-1/2 or equal.

2.04 BALL VALVES

- A. Select with full port opening, blow out proof stem, hard chrome plated forged brass vented ball, adjustable packaging nut, rated not less than 600# W.O.G., 150 W.S.P.
- B. Comply with the following standards:
 - Ball Valves: MSS SP - 110
- C. Domestic Water Service
 - 1. Threaded ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #68, Nibco T-585-70, Apollo 77-100 Series, Watts 6080 or equal.
 - 2. Solder ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #69, Nibco T-585-70, Apollo 77-200 Series, Watts B-6081 or equal.
- D. Natural Gas Service
 - 1. Threaded ends 2" and smaller: 175# W.O.G., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem, U.L. listed for natural gas service: Kitz #60, Nibco GB, Watts GBV or equal.
- E. Deionized Water Service

2.08 VALVE FEATURES

- A. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.
- B. Flanged valve ends comply with ANSI B16.1 (cast iron), ANSI B16.24 (bronze).
- C. Threaded valve ends comply with ANSI B2.1.
- D. Solder Joint valve ends complying with ANSI B16.18.
- E. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials; of standard alloy recognized in valve manufacturing that resist de-zincification.
- F. Butterfly valve designed for flow regulation and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220 psi. No leakage permitted under test.

2.09 VALVE OPERATORS

- A. Provide suitable handwheels for gate, globe and butterfly valves.
- B. For butterfly valves provide gear operators for sizes 8 inches and larger. For smaller sizes provide lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock nut and memory stop for throttling service.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install ball valves for shut-off and isolating service, to isolate equipment, part of systems, or vertical risers.
- C. Provide shut-off valves and check valves on discharge of pumps.
- D. Install check valves in horizontal position with pin horizontally perpendicular to center line of pipe. Install for proper direction of flow. Installations on any vertical piping must be up flow only.
- E. Valves used for natural gas shall be listed for such use.
- F. All valves shall be located so that the bonnets can be removed.
- G. Where valves are installed concealed in pipe chases provide Zurn Z-1460-4 or approved equal access doors with concealed hinge and key operated locks. Door shall be large enough to service valves and shall be installed flush with finished walls.
- H. Install underground domestic water valves in pre-cast concrete valve box with a cast iron lid with "water" cast into lid.
- I. Provide bass tag for each valve labeling the fluid in the pipe, the area served, and the normal operating position.

END OF SECTION

SECTION 220529 - SUPPORTS, ANCHORS AND SLEEVES FOR PLUMBING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe Hangers and Supports

1.2 RELATED WORK

- A. Section 220500 – Common Work Results For Plumbing
- B. Section 221100 – Plumbing Piping

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with Section 220500 Common Work Results For Plumbing.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall be as manufactured by Grinnell, Elcen, Fee and Mason, Unistrut or approved equal.

2.2 INSERTS

- A. Malleable iron case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
- B. Size inserts to suit threaded hanger rods.

2.3 PIPE HANGERS AND SUPPORTS

- A. Hangers: Pipe sizes 1/2 inch to 1-1/2 inch: adjustable wrought steel ring.
- B. Hangers: Pipe sizes 2 inches to 4 inches: adjustable wrought steel clevis.
- C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D. Vertical Support: Steel riser clamp.
- E. Steel Beam Clamps: Elcen Figure 33, Type 3 or approved equal.
- F. Expansion Anchors: Phillips Red Head or approved equal.
- G. Design hangers to impede disengagement by movement of supported pipe.
- H. Provide copper plated hangers and supports for copper piping or two layers Scotch 33 PVC tape or equal.

2.4 HANGER RODS

- A. Provide cadmium plated steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.5 FLASHING

- A. Steel Flashing: 24 gauge galvanized steel.
- B. Lead Flashing: 5 lb./sq.ft. sheet lead for water proofing.
- C. Safes: 5 lb./sq. ft. sheet lead or 8 mil thick neoprene.
- D. Caps: Steel, 22 gauge minimum, 16 gauge at fire resistance structures.

2.6 SLEEVES

- A. Pipes through Walls, Fire Proofing, Footings, and Floor: Form with galvanized steel pipe.
- B. Size large enough to allow for movement due to expansion and to provide for continuous installation.
- C. Seal penetration with sealant per architectural specifications.

PART 3 EXECUTION

3.1 PIPE HANGERS AND SUPPORTS

- A. All structures and appurtenances employed for the purpose of supporting the pipe and guiding it properly shall be carefully fabricated in such a manner as to preserve the true grade of the pipe without subjecting either the pipe or the supporting and guidance members to any undue strain.
- B. Support horizontal piping as follows:
- C. Space hangers and furnish rods as follows:

Nominal Pipe Size (in.)	Span (ft.)		Hanger Rod Diameter (in.)
	Steel	Copper	
1/2	5	5	3/8
3/4	6	6	3/8
1	7	6	3/8
1-1/2	9	8	3/8
2	10	9	3/8
3	10	10	1/2
4	10	10	5/8

- D. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.
- E. Place a hanger within one foot of each horizontal elbow.
- F. Use hangers which are vertically adjustable 1-1/2 inch maximum after piping is erected.
- G. Support piping at each change or direction, at ends of branches, at base and top of riser pipes and drops, and wherever necessary to prevent sag, bending or vibration, in addition to above-listed hanger spacing.
- H. Pipe hangers on insulated lines shall be sized to fit the outside of the insulation.

I. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers, designed to support loads per ANSI B31.1.

J. Where practical, support riser piping independently of connected horizontal piping.

3.2 EQUIPMENT BASES AND SUPPORTS

A. Provide for major equipment minimum four inch thick reinforced concrete house-keeping bases poured directly on structural floor slab pinned in place and extended 6 inches minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment. Coordinate with other trades.

B. Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

C. Provide rigid anchors to ducts and pipes immediately after vibration connections to equipment.

3.3 PRIMING

A. Prime coat non-galvanized steel hangers and supports.

3.4 FLASHING

A. Flash vent and soil pipes projecting 8 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inch minimum clear on sides with minimum 24 inch x 24 inch sheet size. For pipes through outside walls, turn flange back into wall and caulk.

B. Flash floor drains over finished areas with lead 10 inch clear on sides with minimum 36 inch x 36 inch sheet size. Fasten flashing to drain clamp device.

3.5 SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

D. Install chrome plated escutcheons where piping passes through finished surfaces.

E. Size pipe sleeves to permit placing pipe and specified insulation material for pipes passing through concrete or masonry walls or concrete slabs.

F. Sleeves for pipes through floor slabs standard weight galvanized steel pipe with top of sleeve projecting 2 inches above finished floor. For waterproof sleeves.

G. Sleeves for pipe through walls standard weight galvanized steel pipe or 18-gauge galvanized sheet metal with ends flush with wall surface.

H. Seal pipes passing through walls or slabs. Use mastic or oakum seal in the annular space in non-fire-rated walls; use Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal in the annular space in fire-rated walls or other envelopes.

- I. Seal exposed pipe passing through floor slabs with Dow- corning 3-6548 silicone RTV foam firestop sealant or equal and point with caulking compound. Strike off flush at top of sleeve.
- J. Insulated pipe shall be insulated in sleeves, caulked and pointed as above.
- K. Sleeves penetrating exterior walls below grade shall be standard weight, black steel pipe with 1/4" thick steel plate secured to the pipe with a continuous fillet weld. The plate shall be located in the middle of the wall and shall be 4" wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. The pipe passing through the sleeve shall be centered within the sleeve and the annulus opening sealed with "Link Seal" casing seals manufactured by Thunderline Corporation, Wayne, Michigan. Series 300 for pipe sizes 1/2" through 10" and series 400 or 500 for larger pipe sizes or equal.
- L. Pipe sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided for roof penetrations.
- M. All piping shall be installed with due regard to expansion and contraction. Type of hanger, methods of support, location of supports, etc., shall be governed in part by this consideration.

END OF SECTION

SECTION 220700 - PLUMBING INSULATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Insulation of Condensate Drain Piping
- B. Insulation of Domestic and Industrial Hot Water Piping

1.2 RELATED WORK

- A. Section 220500 – Common Work Results For Plumbing
- B. Section 221116 – Plumbing Piping

1.3 QUALITY ASSURANCE

- A. All insulation materials required for piping, and mechanical equipment, etc. shall be furnished and installed under this contract. The execution of the work shall be by approved insulation contractor in strict accordance with the best practice of the trade and the intent of this Specification.
- B. It is mandatory that all insulation be applied in a neat and workmanlike manner. Contractor shall be required to remove and replace all insulation not applied in strict accordance with manufacturer's specifications or not presenting a neat finished appearance.
- C. All insulation on indoor work shall have composite (insulation, jacket or facing, and adhesive used to adhere jacket or facing to the insulation) fire and smoke hazard Ratings, as tested by procedure ASTM E-84, NFPA 255 and UL 73 not exceeding Flame Spread of 25, Fuel Contributed of 50 and Smoke Developed of 50. Accessories, such as adhesives, mastics, cements, tapes and cloths for fittings shall have component ratings as listed above.
- D. Insulation shall be continuous through wall, floor and ceiling openings and sleeves.
- E. Specified mastics, adhesives and coatings shall be applied in strict accordance with manufacturer's instructions, including recommended coverages.

1.4 SUBMITTALS

- A. Submit materials and installation instructions in accordance with Section 220500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Owens-Corning, Knauf, Johns Manville, Certain-Teed, Govain, Benjamin Foster are acceptable provided they meet or exceed these specifications.

2.2 PIPING

- A. Piping:
 - 1. Insulation thickness - Fiberglass pipe covering.

PIPING TYPE	PIPE SIZE	INSULATION SIZE
Domestic & Industrial Hot Water Supply & Return	1-1/4" & under	1"
	1-1/2" & up	1-1/2"
Domestic & Industrial Hot Water Branches	all sizes	1/2"

2. All fiberglass pipe insulation shall be nominal 5 pcf density.
3. Insulation jacket shall be factory applied white All Service Jacket (ASJ), with factory supplied self-sealing laps.
4. Condensate piping may be insulated with 1/2" thick expanded rubber insulation at the contractor's option.
5. Fittings, Valves and Flanges:
 - a. Where manufactured, factory premolded fittings (of the same material and thickness as the pipe insulation) shall be used for all fittings, flanges and valves.
 - b. Where premolded insulation fittings are not manufactured, all fittings, flanges and valves shall be insulated with mitered segments of nominal 5 lb. density fiberglass pipe covering. Hot Service Finish: embed a 20 x 20 weave white glass reinforcing cloth between two 1/16 inch coats of Benjamin Foster 30-36. The glass cloth and second coat shall overlap adjacent covering by at least two inches. Cold Service Finish: same as above except use Benjamin Foster 30-35.
 - c. Insulation for removable flanges of pipe strainers shall be fabricated with built-up sections of Fiberglass pipe covering, so arranged as to facilitate servicing of the strainer. Applications for cold services shall be complete with vapor seals.
6. Insulation on pipes shall be protected by saddles from hangers, guides, and rollers.

PART 3 EXECUTION

3.1 PREPARATION

- A. Do not install covering before piping and equipment has been tested and approved.
- B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 INSTALLATION

- A. Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed.
- B. Insulate fittings and valves. Do not insulate unions, flanges, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material troweled on bevel.
- C. Finish insulation neatly at hangers, supports and other protrusions.
- D. Locate insulation cover seams in least visible locations.
- E. Hot Piping: Cover fittings and valves with equivalent thickness of insulation material.

- F. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

END OF SECTION

SECTION 221116 - PLUMBING PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Lab Waste and Vent Piping Systems
- B. Domestic, Industrial, and Tepid Water Piping Systems
- C. Purified Water Piping System
- E. Natural Gas Piping System
- F. Vacuum Piping System
- G. Pipe Markers

1.2 RELATED WORK

- A. Section 220000 – Common Work Results For Plumbing
- B. Section 220523 – Valves For Plumbing
- C. Section 220529 – Supports, Anchors and Sleeves For Plumbing
- D. Section 224000 – Plumbing Fixtures
- E. Section 220700 – Plumbing Piping Insulation
- F. Section 221119 – Plumbing Specialties

1.3 REFERENCES

- A. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- B. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- C. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder. Joint Drainage Fittings - DWV.
- D. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications.
- E. ANSI/ASTM B32 - Solder Metal.
- F. ANSI/AWS D1.1 - Structural Welding Code.
- G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- H. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.
- I. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

- J. ASTM B88 - Seamless Copper Water Tube.
- K. AWS 5.8 - Brazing Filler Metal.
- 1.4 QUALITY ASSURANCE
 - A. Valves: Manufacturer's name and pressure rating marked on valve body.
 - B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
 - C. Welders Certification: In accordance with ANSI/AWS D1.1.
- 1.5 SUBMITTALS
 - A. Submit product data in accordance with Section 220500.
 - B. Include data on pipe materials, pipe fittings, and accessories.

PART 2 PRODUCTS

2.1 LAB WASTE AND VENT PIPING

- A. Polypropylene Pipe: Schedule 40 polypropylene single containment pipe with sanitary drainage waste & vent (DWV) type fittings with socket fusion weld or mechanical joints. Manufactured by Georg Fischer +GF+ Fuseal, Orion, or approved equal.

2.2 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Tubing: ASTM B88, Type K, annealed. Fittings: NONE. Joints: NONE.
- B. Copper Tubing: ASTM B88, Type K, annealed. Fittings: ANSI/ASME B16.29, wrought copper. Joints: AWS A5.8, BCuP silver braze.

2.3 WATER, INDUSTRIAL WATER, AND TEPID WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L, hard drawn. Fittings: ANSI/ASME B16.23, cast brass, or ANSI/ASME B16.29, wrought copper. Joints: ANSI/ASTM B32, solder, Grade 95TA. equal to Staybrite.

2.4 PURIFIED WATER PIPING

- A. Polypropylene Pipe: ASTM D4101 Schedule 80 high purity homopolymer polypropylene pipe and fittings manufactured to iron pipe sizes to meet the dimensional tolerances of ASTM D2122, with socket electrofusion joints. Manufactured by Georg Fischer +GF+ or approved equal.
- B. Pipe shall be cleaned and capped at time of manufacture.

2.5 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black. Fittings: ANSI/ASME B16.3, malleable iron, or ASTM A234, forged steel welding type. Joints: Screwed for pipe two inches and under; ANSI/AWS D1.1, welded, for pipe over two inches.

2.6 VACUUM PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L, hard drawn. Fittings: ANSI/ASME B16.23, cast brass, or ANSI/ASME B16.29, wrought copper. Joints: ANSI/ASTM B32, solder, Grade 95TA. equal to Staybrite.

2.7 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
- B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; neoprene gaskets for gas service; 1/16 inch thick preformed neoprene bonded to asbestos.
- C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; "C" shape composition sealing gasket; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.8 PIPE MARKERS

- A. Provide pipe markers for all plumbing piping exposed or above lay-in ceilings. This includes lab waste and vent, water, industrial water, tepid water, industrial hot water, industrial hot water return, and natural gas piping.
- B. Pipe markers shall be plastic snap-around type equal of Seton Setmark. Adhesive or stenciled pipe markers are not acceptable for interior installation.
- D. Exterior pipe markers shall be stencil painted markers.
- C. All pipe markers shall meet ASME/ANSI Standard A13.1 for pipe identification.
- D. Pipe markers to include directional arrow for direction of fluid flow.
- E. All exposed natural gas piping shall be painted yellow with a minimum 2 coats of yellow enamel paint in addition to the pipe markers.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain and ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Route piping in orderly manner and maintain gradient.

- C. Install piping to conserve building space and not interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance for installation of insulation and access to valves and fittings.
- G. Provide access doors to match wall or ceiling construction where valves and fittings are not exposed.
- H. Slope water piping and arrange to drain at low points.
- I. Establish elevations of buried piping outside the building to ensure not less than 2 ft of cover.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting where exposed.
- L. Establish invert elevations, slopes for drainage to 1/4 inch per foot (2 percent) minimum for sanitary sewer and lab waste piping.
- M. Apply pipe markers at maximum 10 ft OC and within 5 ft of any wall or roof penetration. Orient pipe markers to be visible from grade or access panel.

3.3 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

3.4 DISINFECTION OF DOMESTIC, INDUSTRIAL, AND TEPID WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C601.
- I. Submit statement of test results and procedures to Architect.

3.5 FLUSHING OF DOMESTIC, INDUSTRIAL, AND TEPID WATER PIPING SYSTEM

- A. Prior to start of work, verify system has been disinfected per paragraph 3.4 of this section.
- B. All installed plumbing fixtures shall be rinsed (ran) daily for a minimum of 30 seconds each. This shall continue for a minimum period of two (2) weeks.
- C. At the conclusion of the flushing cycle, verification samples may be collected by a school representative for testing.
- D. If the testing proves that the lead content is in excess of allowable levels, an additional two (2) week flushing period may be required.
- E. Records of flushing must be maintained and available for inspection.

3.6 FLUSHING OF PURIFIED WATER PIPING SYSTEM

- A. Flush and disinfect purified water piping with "MINNCARE" or equal cleaning solution in accordance with manufacturer's recommendations.

3.7 TESTING

- A. Test lab waste and vent systems by plugging lines and filling systems with water to a static head of ten (10) feet of water. Observe water level for two (2) hours. If level is lowered, indicating leakage, repair leaks and test again until no further leakage is detected.
- B. Test water, industrial water, and tepid water piping piping at 100 psig for a continuous period of four (4) hours. During this time, carefully inspect the system for leaks. If necessary, repair leaks and test again until no further leakage is detected.
- C. Test purified water piping piping at hydrostatic pressure of 100 psig for a continuous period of four (4) hours. During this time, carefully inspect the system for leaks. If necessary, repair leaks and test again until no further leakage is detected.
- D. Test gas and vacuum piping at 50 psig for a continuous period of four (4) hours. During this time, carefully inspect the system for leaks. If necessary, repair leaks and test again until no further leakage is detected.

END OF SECTION

SECTION 221119 - PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Floor Sinks
- B. Cleanouts
- C. Backflow Preventers
- D. Mixing Valve
- E. Hose Bibbs and Hydrants

1.2 RELATED WORK

- A. Section 220500 – Common Work Results For Plumbing
- B. Section 220529 – Supports, Anchors and Sleeves For Plumbing
- C. Section 224000 – Plumbing Fixtures
- D. Section 221116 – Plumbing Piping

1.3 REFERENCES

- A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
- B. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- C. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.

1.4 QUALITY ASSURANCE

- A. Manufacturer: For each type of product specified, provide components by same manufacturer throughout.

1.5 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 220500.
- B. Include component sizes, rough-in requirements, service sizes, and finishes.

PART 2 PRODUCTS

2.1 FLOOR SINKS

- A. Manufacturers: Josam, J.R. Smith, Watts, Zurn or approved equal meeting these specifications are acceptable.

2.2 CLEANOUTS

- A. Manufacturers: Josam, J.R. Smith, Wade, Watts, Zurn or approved equal meeting these specifications are acceptable.
- B. Exterior Surfaced Areas: Round coated cast iron body with cast iron non-skid cover and plug; Model 4225 manufactured by J.R. Smith.
- C. Exterior Unsurfaced Areas: Line type with coated cast iron body and round gasketed cover; Model 4255 manufactured by J.R. Smith.
- D. Interior Finished Floor Areas: Coated cast iron body with round nickel bronze scoriated cover; Model 4020 manufactured by J.R. Smith.
- E. Interior Finished Wall Areas: Line type with coated cast iron body and cast iron lead seal plug, and round stainless steel access cover secured with machine screw; Model 4402 manufactured by J.R. Smith.
- F. Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.3 BACKFLOW PREVENTERS

- A. Manufacturers: Braukmann, Febco, Hersey Beeco, Watts, or approved equal meeting these specifications are acceptable.

2.7 THERMOSTATIC MIXING VALVES

- A. Manufacturers: Leonard, Powers, Symmons, or approved equal meeting these specifications are acceptable.

2.8 HOSE BIBBS AND HYDRANTS

- A. Manufacturers: Chicago, Josam, J.R. Smith, Watts, Wade, Woodford or approved equal meeting these specifications are acceptable.

PART 3 EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in 18 x 18 x 6 inch concrete pad flush with grade.
- D. Encase exterior floor sinks in 18 x 18 x 6 inch concrete pad, 6 inches above grade.
- E. Provide backflow preventer at connection of domestic potable water system to any component which might lead to contamination of the water system.

END OF SECTION

SECTION 222000 - LABORATORY PLUMBING

PART 1 - GENERAL

1.1 INTENT OF LABORATORY PLUMBING SPECIFICATION SECTION

- A. The intent of this section is to provide information which is supplemental to all other divisions and sections of the specifications, and in particular to Division 22 Plumbing work, which shall be specifically related to the plumbing construction within the areas defined under the Laboratory scope of work. It is not intended to make any deletions, either explicitly or implicitly, to any of the other division or section requirements, and these sections do not relieve the Contractor from complying in all respects with other divisions and sections of the specifications. The other divisions and sections shall be considered to be an integral part of the Laboratory Plumbing work and shall be modified only as defined herein. Any questions the Contractor has with respect to the intent of the Laboratory Plumbing work sections should be addressed during the bidding period. Clarifications will be provided upon written request.

1.2 WORK INCLUDED

- A. Provide complete plumbing systems from point of rough-in and final connections as described in these specifications and as shown on the Contract Drawings. Plumbing installations shall include all piping, valves, connectors and miscellaneous equipment to provide complete operable systems, in accordance with the best practices of the trade.
- B. Except as modified by this section, all products, equipment, installation procedures, and general conditions contained within Division 22 Plumbing sections of these specifications applies to work specified in this section.
- C. Work under this section includes, but is not limited to, installation of branch supply piping from main piping systems to points of termination within the laboratories, as well as laboratory waste and vent piping from between floor and ceiling.
- D. Work NOT included under this section is as follows:
 - 1. Laboratory waste piping below point of connection at the floor slab
 - 2. Laboratory vent piping beyond point of connection above ceiling
 - 3. Building distribution main piping systems
 - 4. Fire sprinkler systems
 - 5. Steam and condensate piping systems

Refer to Divisions 21, 22, and 23 for above work.

1.3 RELATED WORK DESCRIBED ELSEWHERE

- A. General and Supplementary Conditions and Division 1
- B. Section 11 53 10 – Laboratory Casework and Other Furnishings
- C. Section 11 53 13 – Fume Hoods and Other Air Containment Units
- D. Section 11 53 43 – Laboratory Service Fittings and Fixtures
- E. Section 11 53 50 – Laboratory Equipment
- F. Division 22 – Plumbing

G. Division 23 – Heating Ventilating and Air Conditioning

H. Division 26 – Electrical

1.4 REFERENCES

A. In addition to complying with all applicable trade and building codes and regulations, comply with applicable portions of the National Sanitation Foundation (NSF) standards.

1.5 DEFINITIONS

A. Above Finished Floor: Inside building within a zone usually considered at $\pm 6"$ above floor finish.

B. Above Finished Ceiling: Inside building within a zone usually considered at $\pm 6"$ above ceiling finish.

C. Below Slab: Located in ceiling space of floor below, buried in ground, or embedded in concrete slab on ground.

D. Concealed: Inside building, above grade and located within walls, furred spaces, service cores, pipe drop enclosures, above suspended ceilings, etc. In general any item not visible or directly accessible.

E. Connect: Complete hookup of item with required services, including all adapters and fittings.

F. Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms. In general any item that is directly accessible without removing panels, walls, ceiling or other parts of structure commonly used as reference to surface mounted piping, etc.

G. Point of Connection: Point within a piped system at which responsibility of this section either begins or ends. i.e. laboratory waste begins at fixture outlet and ends at Point of Connection (P.O.C.) $\pm 6"$ above floor finish. From there to be continued on Plumbing Drawings, and remainder of Division 22 specifications.

1.6 CLOSING IN UNINSPECTED WORK

A. Do not cover or enclose work prior to testing, inspection, and approval. All work covered or enclosed prior to approval and acceptance shall be re-opened. All finishes shall be restored.

1.7 SUBMITTALS

A. Submit as specified herein and under provisions of Division 1 "Submittal Requirements".

B. Submittal shall be complete with all product data specified herein and organized by specification reference section into a single electronic file. All submitted product data shall be referenced to the applicable paragraph number contained within this specification section.

C. Manufacturer's Data: Submit complete materials list, including catalog data, of all materials, equipment, and products for work in this section.

D. Shop Drawings: Submit coordinated shop drawings depicting the work specified herein for actual fabrication and installation. Work shall be coordinated with other trades and building structural and architectural elements. Shop drawings shall include plans, elevations, and sections as required depicting the intended installation and final product. Drawings shall be electronically prepared in AutoCAD or similar software and submitted in a complete package

with minimum ¼ inch = 1 ft scale format and maximum sheet size of Architectural "E" (30" x 42").

1.8 RECORD DRAWINGS

- A. The Contractor shall maintain an up-to-date set of "red-line" prints, marked to indicate progress of the Project and all as-built conditions. Prints shall be updated on a daily basis, and shall be available for review at all times on the job site.
- B. Record Drawings shall indicate locations of all equipment and pipe rerouting, as well as any changes in locations or positions of equipment.
- C. Comply with Division 1 "Project Closeout" for Record Drawings requirements.

1.9 SUBSTITUTIONS

- A. Approved Substitution/Approved Equal: In addition to the items required in Division 1, all substitution requests shall include item-by-item comparison of the proposed substitution to this project specification. A copy of the project specification shall be submitted, with each item and subsection of the project specification marked as "Comply" or "Not Comply." In any cases where "Not Comply" is indicated, an explanation of the relative advantages of the proposed design shall be provided.
- B. Substitution shall not affect dimensions shown on Drawings.
- C. The Contractor shall pay for changes to the building design, including engineering design, detailing, utility and service requirements, and construction costs caused by the requested substitution.
- D. Substitutions shall have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
- E. Maintenance and service parts shall be locally available for the proposed substitution.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

- A. Domestic and Industrial Cold and Hot Water:
 - 1. Provide Type L copper pipe and fittings as specified in Section 22 11 16.
 - 2. Flexible Connectors:
 - a. Sink Faucet Fixture Connections: Braided stainless steel flexible water supply connector, 125 psi working pressure, 40-150°F working temperature, PVC hose, nickel plated brass connectors, Santoprene washers. Manufacturers: Brasscraft, Fluidmaster, or approved equal.
 - b. Equipment Connections: Provide 150 psi WOG working pressure rating, single braid, and stainless steel hose with chrome plated brass threaded end connections. Manufacturers: US Hose Corp., Hyspan, or approved equal.
 - 3. Flexible Tubing: Provide ASTM B 88 Type L, soft, annealed, seamless copper tubing.
 - 4. Water Hammer Arrestors: Provide ASSE 1010, ANSI A112.26.1, or PDI-WH 201 certified copper tube with piston arrestor constructed of Type K or L hard drawn copper body, brass piston with lubricated dual O-ring seals, and threaded wrought copper or brass MIP connector. Manufacturers: PPP Inc., Sioux Chief, or approved equal.

B. Purified Water:

1. Provide ASTM D4101 Schedule 80 high purity homopolymer polypropylene (PP) pipe and fittings manufactured to iron pipe sizes to meet the dimensional tolerances of ASTM D2122, with socket electrofusion joints. Manufacturers: Georg Fischer +GF+ or approved equal.
2. Pipe shall be cleaned and capped at time of manufacture.
3. Provide continuous (linear piping) tray-type channel support ("V" or "U" shaped sheet metal or fiberglass) along entire horizontal ceiling distribution of piping system.
4. Fixture Flexible Connectors: Pure water 3/8" O.D. polypropylene tubing with polypropylene threaded compression fittings. Grab ring or slip compression type fittings are not acceptable.

C. Vacuum:

1. Provide Type L copper pipe and fittings as specified in Section 22 11 16.
2. Threaded joints in distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1 and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.
3. Flexible Connectors: Provide 150 psi WOG working pressure rating, single braid, stainless steel hose with brass threaded end connections. Manufacturers: US Hose Corp., Hyspan, or approved equal.

D. Compressed Air (As required for small autoclave, refer to Section 115350):

1. Provide ASTM B 88, Type L, seamless, hard-drawn, tempered, copper tubing. Fittings shall be ASME B16.22, wrought copper, solder joint. All joints shall be soldered with ASTM B 32 lead-free alloys and water-flushable flux according to ASTM B 813.
2. Threaded joints in distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1 and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.

E. Laboratory (Natural) Gas:

1. Provide black steel pipe and fittings as specified in Section 22 11 16.
2. Flexible Piping: Provide corrugated stainless steel tubing (CSST) flexible piping for final connections to laboratory gas service fittings as indicated in the Laboratory Plumbing drawings. CSST flexible gas piping with mechanical attachment flare fitting shall conform to the latest ANSI/AGA Standard LC-1. CSST tubing one-piece constructed of stainless steel with flame retardant polymer or polyethylene coating, color yellow or black. Nuts, fitting adapter, and split rings shall be constructed of zinc-plated steel or brass. Note that flexible appliance connectors that comply with ANSI Z21-24/CSA 6.10 or similar appliance connector standards are not appropriate for this application.

a. Manufacturers:

- 1). BrassCraft Manufacturing
- 2). Tru-Flex Metal Hose Corporation
- 3). Omega Flex Inc.
- 4). Titeflex Corporation
- 5). Ward Manufacturing

- 6). Or approved equal
 - b. All products specified in this section shall be the provided by a single manufacturer.
 - c. Length: Length of flexible piping segment for final connection to service fitting shall not exceed 24 inches.
- F. Laboratory Waste and Vent:
1. Provide Schedule 40 flame-retardant polypropylene (PP) single containment pipe with sanitary type fittings. Manufacturers: Georg Fisher +GF+ Fuseal, Orion, or approved equal.
 - a. Joints:
 - 1). Polypropylene (PP), fusion weld, per manufacturer's instructions. Installed behind walls, partitions, inaccessible ceiling spaces etc., unless otherwise noted.
 - 2). Polypropylene (PP), mechanical joint, per manufacturer's instructions. Installed in areas exposed to view, accessible ceiling spaces, fixture P-trap connections (both ends), and areas subject to ease of retrofit of the system.
 - 3). Mechanical joints within sink cabinets and other areas exposed to view shall be threaded or grooved style piping joints. Compression bands shall not be used in these locations.
 2. Provide chrome-plated brass waste piping for tailpiece, P-trap, and trap arm at exposed-to-view locations for installations of emergency eyewash Laboratory fixtures and wall-hung hand wash sinks.
- G. General Purity Specialty Gases:
1. Application:
 - a. Nitrogen (N₂)
 2. Piping: Provide ASTM B 75 seamless, hard-drawn, tempered, copper tubing. Tube and fittings shall meet the following dimensional tolerance: O.D. 1/4", wall thickness 0.030" (±5%); O.D 3/8", wall thickness 0.035" (±5%); O.D. 1/2" – 5/8", wall thickness 0.049" (±5%); O.D 3/4" – 1-1/4", wall thickness 0.065" (±5%). Tubing shall be cleaned, capped and delivered certified for "Medical Gas", "Oxygen Service", or equivalent cleanliness standard from the manufacturer. Manufacturer: Swagelok or approved equal.
 3. Fittings:
 - a. Tube and Adapter Fittings: Provide brass gageable tube fittings consisting of body, front ferrule, back ferrule and nut with gap inspection gages to ensure proper installation to manufacturer's standards. Manufacturer: Swagelok or approved equal.
 - b. Brazed Fittings: Fittings shall be ASME B16.22 wrought copper, brazed joints. Joints shall be silver brazed in accordance with ASTM F1076-87 with silver alloy filler Stay Silv 15, Sil-Fos 15, or equal.
 - c. Fittings shall be cleaned, capped and delivered certified for "Medical Gas", "Oxygen Service", or equivalent cleanliness standard from the manufacturer.
 4. Threaded joints in distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, valves, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1 and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with

the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.

2.2 VALVES

A. Domestic and Industrial Cold and Hot Water:

1. Fixture Supply Stop Valves:
 - a. Provide angle pattern, ¼-turn ball, loose key with lockshield supply stop valve. Brass body and stem chrome plated, metal oval key handle. Provide chrome finished metal escutcheon, 125 psi working pressure, 40-180°F rating, 1/2-inch FIP inlet x 3/8-inch O.D. outlet. Manufacturers: BrassCraft, Dahl, or approved equal.
2. Shutoff Valves:
 - a. Provide ball valves as specified in Section 22 05 23.
3. Vacuum Breakers: Provide vacuum breakers on potable water services as accepted by local building Authority. Manufacturers: Watts, Sloan, or approved equal.
4. Back Flow Preventers: Provide reduced-pressure-principle backflow preventers on potable water services supplying laboratory equipment, as accepted by local building Authority, and as specified in Section 22 11 19.
5. Pressure Regulators: Provide adjustable water pressure regulators service fitting connection size. Manufacturers: Watts Series N, Fisher Type 75A, or approved equal.
6. Ice Maker Water Valve Box:
 - a. Provide all-metal recessed wall box fabricated of minimum 20-gauge steel with steel faceplate. Provide white epoxy powder coated finish. Approximate overall dimensions: 7-inch wide x 7-inch high x 3-inch deep.
 - b. Valve box equipped with quarter turn, angle pattern, brass, stop ball valve with ½-inch MIP x ¼-inch compressing connections with integral top mounted water hammer arrestor.
 - c. Manufacturers: LSP Products Group model OB-509 or approved equal.
7. Industrial Hot/Cold Water Valve Box with Waste Fitting (Stainless Steel):
 - a. Provide recessed wall box fabricated of minimum 18-gauge type 304 stainless steel with satin finish. Approximate overall dimensions: 10 ½-inch wide x 10 ½-inch high x 3 5/8-inch deep.
 - b. Valve box to be equipped with hot water, cold water, and waste fittings as required for equipment services. Provide valve box with hot and cold water vacuum breaker.
 - c. Manufacturers: Acorn Engineering Company model 8186 or approved equal.
8. Industrial Cold Water & Purified Water Valve Box (Painted Steel):
 - a. Provided to supply cold and purified water to benchtop autoclaves on stands, refer to floor plan and detail.
 - b. Valve Box:
 - 1). Provide recessed wall box fabricated of minimum 20-gauge steel with white epoxy powder coated finish. Approximate overall dimensions: 14-inch wide x 9-inch high x 3-inch deep.
 - 2). Valve box to be equipped with cold and purified water fittings as required for equipment services.

- 3). Manufacturers: Guy Gray Manufacturing Company model T150 or approved equal (no known equal).
- c. Valves:
 - 1). Cold Water Valve:
 - a). Guy Gray supplied cold water fitting, ¼ Turn valve with 1/2" MIP/sweat connection.
 - 2). Purified Water Valve:
 - a). Polypropylene needle valve with Teflon PTFE seal. Valve to be provided with ½" FNPT inlet and ¼" or ½" NPT outlet.
 - b). Manufacturers: Marquest Scientific model NA-500-PPR, WaterSaver model L73100F-1/4PP, or approved equal.
- B. Purified Water:
 1. Control, Branch and Shut-off Valves:
 - a. Provide homopolymer polypropylene ball valves compatible with piping and fittings. Manufacturers: Georg Fischer +GF+ or approved equal.
 2. Pressure Gauges:
 - a. Manufacturers: Ashcroft, Watts, Terice, or approved equal.
 - b. Standard: ASME B40.100.
 - c. Case: Liquid-filled type; cast aluminum or drawn steel 4-1/2-inch nominal diameter.
 - d. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - e. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type.
 - f. Movement: Mechanical, with link to pressure element and connection to pointer.
 - g. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
 - h. Pointer: Dark-colored metal.
 - i. Window: Glass.
 - j. Ring: Stainless steel.
 - k. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.
 3. Pressure Reducing Valve:
 - a. Manufacturers: Plastomatic or approved equal.
 - b. 10-125 PSI downstream pressure setpoint range.
 - c. ½" NPT connection.
- C. Vacuum:
 1. Shutoff Valves:
 - a. Provide two-piece, full port, bronze ball valve with bronze trim and soldered ends, MSS SP-110, 600 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, bronze stem, brass ball with hard chrome plate, and blowout-proof stem. Manufacturers: Nibco, Apollo, or approved equal.
- D. Compressed Air:

1. Shutoff Valves:
 - a. Provide two-piece, full port, bronze ball valve with bronze trim and soldered ends, MSS SP-110, 600 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, bronze stem, brass ball with hard chrome plate, and blowout-proof stem. Manufacturers: Nibco, Apollo, or approved equal.
- E. Laboratory (Natural) Gas:
 1. Shutoff Valves:
 - a. Provide two-piece, full port, brass or bronze ball valve with brass trim and threaded ends, 400 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, brass stem, brass ball with hard chrome plate. Quarter-turn (closed to fully open) design, vinyl-coated steel lever handle requiring less than 5 lbs. pressure to operate. Ball valves shall comply with NFPA 54, and be UL listed and AGA/CGA certified for natural gas service. Manufacturers: Nibco, Apollo, or approved equal.
 2. Zone Shutoff Valve Box:
 - a. Provide recessed zone valve box assembly consisting of the following components: minimum 16-gauge steel recessed valve box with white baked enamel finish, flush box door, continuous concealed door hinge, and 7.5" x 5.5" vision panel. Provide recessed zone valve box assembly with flush paddle handle latch, lock and key is not acceptable. Approximate recessed dimensions: 12-inch wide x 12-inch high x 4-inch deep.
 - 1). Identification:
 - a). Zone valve box to be provided with engraved plastic label "LABORATORY GAS CONTROL VALVE", "CLOSE ONLY IN EMERGENCY". Engraved label to have white lettering on black label.
 - b. Manufacturers: Acudor model ARVB or approved equal.
- F. General Purity Specialty Gases:
 1. Application:
 - a. Nitrogen (N₂)
 2. Valves: Provide three-piece, full-port, bronze ball valve, stainless-steel trim, with soldered or threaded ends or copper tube extensions for brazing, MSS SP-110, 600 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, stainless steel stem and ball (vented), blowout-proof stem. Valve shall be cleaned, capped and delivered certified for "Oxygen Service" from the manufacturer. Manufacturers: Nibco, Apollo, or approved equal.

2.3 MANIFOLDS

- A. Manufacturers: Products, which comply with this specification section as judged and approved by the Owner's representative, may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
 1. Advanced Specialty Gas Equipment
 2. Applied Energy Systems, Inc.
 3. Concoa
 4. Linde Spectra Gases, Inc.

5. Praxair
 6. Or approved equal
- B. General Purity Semi-Automatic Cylinder Manifold System Assembly for Multiple Cylinders:
1. Application:
 - a. Nitrogen (N₂)
 2. General: Provide semi-automatic changeover assembly for continuous supply of gas from active and reserve cylinder banks. Dual-stage regulator assembly consisting of inlet regulator, selector knob, line regulator, accessories, and mounting plate. Assembly shall be complete and ready for use upon cylinder hookup. Inlet pressure rating of 3,000 psig; assembly line delivery pressure range 30 – 125 psig (unless otherwise noted).
 3. Regulator: General purity diffusion resistant type regulator, brass body, nickel-plated brass bonnet, neoprene diaphragm, EPDM seats, metal-to-metal seals on the diaphragm.
 - a. Provide gas heater for CO₂ regulators and other gases subject to excessive cooling.
 4. Check Valves: Check valves shall be integral to the CGA connection, brass, and furnished with Viton O-rings.
 5. Gauges: Bourdon tube type, brass construction, 2-inch face for inlet and outlet pressures. Accuracy $\pm 2\%$ of full scale. Inlet pressure: 0 – 2,000 psig range. Outlet pressure: 0 – 200 psig or 1.25 times system operating pressure. Changeover assembly shall include pressure gauges to indicate pressures for service bank, reserve bank, and delivery.
 6. Relief Valve: Seat-type relief valve, brass housing with Viton O-ring and adjustable setting.
 7. Isolation Valve: Forged brass, general purity packed valve. Provide at outlet, inlets to allow isolation of either side of the changeover assembly, and at each cylinder connection.
 8. Manifold Piping: Install manifold headers consisting of seamless brass tube rated for 3,000 psig with individual station isolation valves. Provide brass tees and couplers.
 9. Flexible Hose Inlet Assembly: Teflon lined braided steel flexible hose pigtail with a CGA cylinder connection with integral check valve rated for 3,000 psig working pressure. Provide one inlet hose assembly for each connected cylinder.
 10. Mounting Plate: Manifold assembly shall be attached to an anodized aluminum or stainless steel mounting plate (No. 4 finish or better), functionally labeled, pre-drilled and ready for wall mounting.
 11. Pressure Switch: Switch senses differential cylinder pressure to activate alarm; non-powered, single-pole, double-throw, 125 vac, 5 amp, 60 Hz. Provide required conduit and wiring for system operation.
 12. Entire assembly helium leak checked to 1×10^{-6} scc/sec out board with a mass spectrometer. Dead end pressure tested for 12 hours creep test.
 13. Alarm Annunciator Panel: Provide alarm annunciator panel equipped with red (alarm) and green (normal) system status lights, minimum 80 dB audible alarm, audible alarm silence button, and test button. Panel shall include power cord to plug into a 120vac 60 Hz electrical supply receptacle and be equipped with integral 120vac/24vac step-down power transformer as required. Provide permanent engraved labeling to identify alarm channel gas nomenclature. Provide single-channel panel for a single monitored cylinder or multi-channel panel for multiple monitored gas cylinders arranged adjacent to each other.

2.4 PROTECTIVE PIPE COVER (AT EXPOSED P-TRAP ARMS)

- A. Manufacturers: Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.
 - 1. Truebro, Inc., <http://www.ipscorp.com/truebro>
 - 2. Approved equal
- B. Basis of Design: Truebro LAV GUARD undersink protective pipe cover.
- C. Description; Flexible, molded, antimicrobial, closed cell vinyl pipe cover and fittings for P-trap, angle valve, tailpiece, extension arm, supply tube, etc. components below sink.
- D. Material Characteristics:
 - 1. Wall thickness: 1/8 inch (3 mm)
 - 2. Durometer: 60 – 70 Shore A
 - 3. Finish: Smooth high gloss
 - 4. Color: White
 - 5. UV Protection: Will not fade or discolor
 - 6. Flame Characteristics (ASTM D 635): 0 sec. (ATB), 0 mm (AEB)
 - 7. Thermal conductivity (K value): 1.17 plus dead air space
- E. Features:
 - 1. Fasteners: Reusable snap clips
 - 2. Protective wrap shall install without disassembling plumbing
 - 3. Latching covers to access angle stops
 - 4. Removable cleanout nut for servicing

2.5 INSULATION

- A. Insulate laboratory piping as specified in Section 22 07 00 for the respective systems.

2.6 PIPING HANGERS, SUPPORTS AND GUIDE

- A. Provide hangers and supports as specified in Section 22 05 29.

2.7 PIPING AND EQUIPMENT IDENTIFICATION

- A. Provide identification for plumbing piping and equipment per ASME 13.1 and as specified in Section 22 11 16.

PART 3 - EXECUTION

3.1 CONNECTION

- A. Connect laboratory piping to P.O.C. valves shown on Plumbing drawings and to laboratory services. Provide threaded couplings at final connection to service fittings and valve stops.
- B. Laboratory Waste and Vent:
 - 1. Laboratory Waste: Connect laboratory fixture/outlet waste to P.O.C. of laboratory waste. Extend piping from tail piece connector with trap and trap arm,
 - 2. Laboratory Vent: Connect fixture trap arm to P.O.C. of laboratory vent.

3.2 INSTALLATION

A. Domestic and Industrial Cold and Hot Water:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings. Provide threaded couplings at final connection to service fittings and valve stops.
2. Install approved pressure regulators on laboratory equipment connections when required by equipment manufacturer. Set delivery pressure within equipment manufactures' specifications.
3. Install water hammer arrestors on water piping that serves quick closing or solenoid operated valves for equipment or laboratory services. Water hammer arrestors shall be installed upstream of these valves in accordance with manufacturer's recommendations.
4. Fixture Connection: Install supply stop valve for each service to fixture as indicated on LP-series drawings. Install flexible connector or flexible tubing from valve to fixture supply water connections.
5. Extend cold domestic water piping from P.O.C. to drench hoses and safety shower/eyewash units as indicated on LP-series drawings.
6. Refer to corresponding sections of Division 22 for system cleaning and disinfecting requirements.

B. Purified Water:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings.
2. Fixture Connection: Install supply shutoff valve for each fixture as indicated on LP-series drawings. Install flexible tubing from valve to fixture supply water connection.
3. Cleaning:
 - a. Refer to corresponding sections of Division 22 for system cleaning and disinfecting requirements.
 - b. If not specified elsewhere, minimum requirements shall be to flush and disinfect new water lines with "MINNCARE" or equal cleaning solution in accordance with manufacturer's recommendations.

C. Laboratory Vacuum:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings.
2. Fixture Connection: Install flexible connector from piping to fixture connection as indicated on LP-series drawings.
3. Cleaning:
 - a. Refer to corresponding sections of Division 22 for system cleaning requirements.
 - b. If not specified elsewhere, system shall be purged with dry, oil-free compressed air to remove all loose dirt/dust/debris.

D. Compressed Air:

1. Copper Tubing Brazing Procedures:
 - a. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper-phosphorus-silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8 Specification for Brazing Filler Metal. Residual flux on interior surfaces of tubing and fittings must be completely removed with cleaning processes.

- b. While being brazed, all piping joints shall be continuously purged with oil-free, dry Nitrogen to prevent the formation of copper oxide on the inside surfaces of the joint. The purge shall be maintained until the joint is cool to the touch.
 2. Cleaning:
 - a. Refer to corresponding sections of Division 22 for system cleaning requirements.
 - b. If not specified elsewhere, system shall be purged with dry, oil-free compressed air to remove all loose dirt/dust/debris.
- E. Laboratory (Natural) Gas:
1. Extend piping from P.O.C. to services as indicated on LP-series drawings.
 2. Fitting Connection: Install flexible piping from rigid piping to service fittings as indicated in the LP-series drawings.
 3. Installation Standards: Install gas piping in accordance with NFPA 54.
 4. Install in-line shutoff valves at locations and per details shown on LP-series drawings.
- F. Laboratory Waste and Vent:
1. Install horizontal pipe with uniform slope of 1/4-inch per foot (minimum).
 2. Use reduction fittings, not bushings, to connect pipes of different diameters.
 3. Change direction by appropriate use of 45-degree wyes, long sweep quarter-bends, and sixth-, eighth-, and sixteenth-bends.
 4. All fixture traps shall be of the "P" type with mechanical joints for removal.
 5. No vent shall intersect another vent at a point less than six inches above the extreme overflow level of the highest fixture served unless said fixtures are located back to back, in which a sanitary "TEE" may be used.
 6. Vents shall be taken off the top half of horizontal runs and shall be graded so as will quickly drain any water or condensate.
- G. Specialty Gases:
1. Application:
 - a. Nitrogen (N₂)
 2. Comply with NFPA 45-2011. Install specialty gas piping as specified and as shown on drawings.
 3. Provide and install pressure regulators and cylinder manifolds where shown on drawings.
 4. Provide piping from cylinder manifold systems within laboratory room to services as shown on LP-series drawings. Provide threaded couplings at final connection to service fittings.
 5. Install service fittings as shown on drawings.
 6. Copper Tubing Brazing Procedures:
 - a. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper-phosphorus-silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAG series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8 Specification for Brazing Filler Metal. Residual flux on interior surfaces of tubing and fittings must be completely removed with cleaning processes.

- b. While being brazed, all piping joints shall be continuously purged with oil-free, dry Nitrogen to prevent the formation of copper oxide on the inside surfaces of the joint. The purge shall be maintained until the joint is cool to the touch.
 - c. The outside of all tubes, joints, and fittings shall be cleaned by washing with hot water after assembly to remove any excess flux and provide for clear visual inspection of brazed connections.
7. Cleaning:
- a. General: All tubing, fittings, and valves shall be delivered to the site cleaned, capped, and protected. If contamination occurs, the item shall be replaced at no additional cost to the Owner. Mass cleaning and/or re-cleaning on site will not be permitted. Cleaning components on site shall be restricted to that required when tubing is cut. Items shall be cleaned in strict compliance with the provisions of the purity level of the piping system. Valves and fittings which become contaminated shall be replaced at no cost to the Owner.
 - b. General Purity Specialty Gases: Items shall be cleaned by the supplier in strict compliance with the provisions of "Oxygen" services.

3.3 TESTS

- A. Contractor shall thoroughly test all Work prior to operation in the presence of Owner's Representative. Any Work showing faults under test shall be replaced. Contractor shall maintain an accurate written record of all tests and test results, and shall submit three copies of all final tests to the Owner's Representative.
- B. Refer to Division 22 specifications for system test requirements. If not specified elsewhere, minimum requirements shall be as follows:
 - 1. Domestic and Industrial Cold and Hot Water: Test under a cold water hydrostatic pressure of 150 psig for a period of four (4) hours and carefully check for leaks. Repair all leaks and re-test system until proven watertight with no loss of pressure or leakage allowed.
 - 2. Purified Water: Do not conceal any piping until satisfactorily tested. Test and prove tight under a hydrostatic pressure of 100 psi for a period of four (4) hours and carefully check for leaks. Repair all leaks and re-test system until proven watertight with no loss of pressure or leakage allowed.
 - 3. Laboratory Vacuum: Test and prove airtight under an air pressure of 50 psig for a period of four (4) hours and bubble test all joints with a soap solution. Following pressure test, perform vacuum hold test pressure of -25" Hg for a period of four (4) hours with a maximum vacuum degradation of 1.25" Hg allowed. Repair all leaks and re-test system until proven airtight.
 - 4. Compressed Air: Test and prove airtight under an air pressure of 150 psig for a period of four (4) hours and bubble test all joints with a soap solution. Repair all leaks and re-test system until proven airtight with no loss of pressure or leakage allowed.
 - 5. Laboratory (Natural) Gas: Test and prove gas-tight under an air pressure of 50 psig for a period of four (4) hours and bubble test all joints with a soap solution. Repair all leaks and re-test system until proven gas-tight with no loss of pressure or leakage allowed. Make a final 24-hour standing pressure test with air at 20 psig before connecting equipment. Retest the system until it is proven free of leaks.
- C. General Purity Specialty Non-toxic, Non-Flammable Gases:
 - 1. General:

- a. Prior to testing operation, open valves and blow out pipelines to remove foreign matter.
 - b. Perform testing in presence of the Owner's Representative.
 - c. Use 99.995% purity Nitrogen for purging and for pressure and leak testing.
 - d. Observe safety procedures at all times.
 - e. Use gauges cleaned for "Oxygen" service.
2. Pressure Tests:
- a. Nitrogen Pressure Test: The line shall be pressure-tested at 200 psig or 1-1/2 times the operating pressure (whichever is higher) for 24 hours. The line pressure shall be monitored and corrected for ambient temperature.
3. Leak Tests:
- a. Nitrogen Pressure Test: The line pressure shall be brought up to test pressure. Perform bubble test of all joints with a soap solution. Repair all leaks and re-test system until proven gas-tight with no loss of pressure or leakage allowed.

END OF SECTION 222000

SECTION 223000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Water heater
- B. Purified Water system

1.2 RELATED WORK

- A. Section 220000 – Common Work Results For Plumbing
- B. Section 220523 – Valves For Plumbing
- C. Section 220529 – Supports, Anchors and Sleeves For Plumbing
- D. Section 220640 – Plumbing Fixtures
- E. Section 220719 – Plumbing Piping Insulation
- F. Section 221119 – Plumbing Specialties

1.3 REFERENCES

- A. ANSI/ASME Section 8D - Pressure Vessels.
- B. ANSI/NFPA 70 - National Electrical Code.

1.4 QUALITY ASSURANCE

- A. Provide pumps with manufacturer's name, model number, and rating/ capacity identified.
- B. Ensure products and installation of specified products are in conformance with recommendations and requirements of following organizations:
 - 1. National Sanitation Foundation (NSF).
 - 2. American Society of Mechanical Engineers (ASME).
 - 3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
 - 4. National Electrical Manufacturers' Association (NEMA).
 - 5. Underwriters Laboratories (UL).
- C. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

- A. Submit product data in accordance with Section 220500.

- B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
- C. Indicate pump type, capacity, power requirements, and affected adjacent construction.
- D. Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data in accordance with Section 220500.
- B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.7 WARRANTY

- A. Provide three year manufacturer's warranty in accordance with Section 220500.
- B. Warranty: Includes coverage of water heaters and in-line circulator.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - WATER HEATERS

- A. Products manufactured by Rheem/Ruud, Bradford White, A.O. Smith, State, or approved equal meeting these specifications are acceptable.

2.2 ELECTRIC WATER HEATER

- A. High efficiency, automatic, electric heating element, vertical storage type, 150 psig maximum working pressure.
- B. Glass lined welded steel tank, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked- on enamel finish; floor shield and legs.
- C. Brass water connections and dip tube, drain valve, high-density magnesium anode, and ASME rated temperature and pressure relief valve.
- D. Unit approved by AGA as automatic storage water heater.
- E. Minimum thermal efficiency rating of 95%.
- E. Automatic water thermostat with temperature range adjustable from 105 to 180 degrees F.
- F. Automatic direct immersion thermostat with temperature range adjustable minimum 175 degrees F differential, automatic reset high temperature limiting thermostat, factory set at 205 degrees F gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple.

2.3 ACCEPTABLE MANUFACTURERS – WATER SOFTENER

- A. Products manufactured by Culligan, PureTec, Kinetico, Marlo, Columbia, Rainsoft, CSI, or approved equal meeting these specifications and the plan documents are acceptable.

2.4 WATER SOFTENER

- A. Water quality requirements for maximum 100 gpm and minimum 5 gpm for the removal of calcium and magnesium ions to less than one grain of hardness.
- B. This system shall include stainless steel or FRP single mineral tank with 2" minimum 7 cubic foot resin and 150 lbs gravel, 2" stainless steel meter assembly, polyethylene brine tank for minimum 100 gallons and 900 lbs salt, and controller.
- C. Provide salt for start-up.
- D. Provide factory start-up and commissioning.

2.5 ACCEPTABLE MANUFACTURERS – DEIONIZED WATER SYSTEM

- A. Products manufactured by Culligan, PureTec, Kinetico, Marlo, Columbia, CSI, or approved equal meeting these specifications and the plan documents are acceptable.

2.6 DEINIONIZED WATER SYSTEM

- A. Provide purified water system to serve the equipment described in the lab drawings. Contractor shall review this equipment prior to submitting to verify adequate water quality and capacity for this equipment and use.
- B. System shall provide ASTM Type II water, deionized water, meeting the requirements for the equipment listed above.
- C. The current design is based on the following equipment:
 - 1. 10 gpm DI recirculator, 3-hp, 460V/3ph
 - 2. 5 micron prefilter and housing
 - 3. UV Sterilizer for 15 gpm, 120V, with lamp-out alert
 - 4. (3) 0.2 micron filters with 20" housing
 - 5. Pump discharge flow sensor
 - 6. Loop supply quality sensor
 - 7. All valves, gauges, and accessories
 - 8. Control panel

All components shall be factory skid mounted or field installed.

- D. Four mix bed resin tanks, 14" diameter x 50" tall, with all valves, hose kits, fittings, and controller, 120V.
- E. Provide factory start-up, commissioning, and training.

2.7 ACCEPTABLE MANUFACTURERS – VACUUM PUMPS

- A. Products manufactured by Amico, Beacon, Busch, Gardner Denver, Quincy, or approved equal meeting these specifications and plan documents are acceptable.

2.8 VACUUM PUMPS

- A. The vacuum pumps shall be a triplex stack mounted vacuum system as scheduled on the drawings.

- B. The stack mounted vacuum system shall be a completely packaged and NEC compliant assembly with dry rotary vane vacuum pumps, a U.L. listed electrical control cabinet, an ASME receiver and the necessary accessories required to meet and exceed the current code requirements. All components shall be pre-piped and pre-wired to single point service connections. The only field connections shall be air intake, air discharge and power connection at the control panel. All interconnecting piping, as well as wiring, shall be completed and operationally tested prior to shipment. Liquid tight conduit, fittings and junction boxes shall be provided for all control and power wiring.
- C. The vacuum pumps shall be continuous duty rotary vane air-cooled type equipped with non-asbestos vanes, having a minimum life of 30,000 to 40,000 hours. The pumps shall be provided with fully recirculated oil supply. The oil separation shall be integral and consist of for stages or internally installed oil and smoke eliminators. This system shall be capable of removing 99.9+% of oil and smoke particles from the exhaust. Each vacuum pump shall be driven by a 3-phase, 60-cycle motor.
- D. The system shall include a vacuum storage tank of ASME construction rated for full vacuum service. The tank shall be equipped with a vacuum gauge, valved by-pass and manual tank drain. The inside of the tank shall be provided with a two-component coating to provide a hard durable lining.
- E. Each vacuum pump shall include an inlet and outlet check valve, inlet and outlet isolation valve, inlet gauge, built-in anti-suck-back valve, inlet filter, sight gauge to indicate oil level, oil temperature gauges, pump drain valve, high exhaust pressure gauge, vacuum control switch, bronze or stainless steel flexible connectors on inlet and discharge lines as well as copper tubing with shut-off cock for gauge and vacuum switches.
- F. The system shall include a UL listed control panel in a NEMA 12 enclosure. The panel shall include the following accessories for each pump:

Externally operable fusible disconnect with door interlock, control circuit transformer with fused primary and secondary coils, H-O-A switch, run light, hour meter, magnetic starter with 3 leg overload protection and reset switch and minimum run timer to prevent short cycle operation. The panel shall be equipped with a multiple position selector switch for selection of normal operation (automatic alternation) or manual selection of lead and lag pumps if one of the pumps is taken out of service due to scheduled maintenance. Field adjustable control switches shall be provided to automatically start and stop each pump based on tank vacuum pressure.
- G. Local "Back-up in use" and "low pressure" audible and visual alarms shall be provided. The alarm shall include an indicating light as well as the horn. The audible alarm shall be acknowledged with a "Silence" button. The visual alarm shall remain energized until the problem has been corrected. Each alarm function shall include a set of dry contacts for connection to the master alarm. All control and alarm functions shall remain energized while any vacuum pump in the system remains electrically on-line.
- H. The Vacuum system shall be guaranteed by the manufacturer for a period of 12 months from the date of start-up or 18 months from the date of shipment against defects in design, materials, or construction. In addition, the bare pumps shall be guaranteed for 36 months from the date of shipment.

PART 3 EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters in accordance with manufacturer's instructions and to NSF and UL requirements.

3.2 WATER SOFTENER AND DEIONIZATION SYSTEM INSTALLATION

- A. Install all equipment on minimum 4" high concrete pad.
- B. Install all equipment in accordance with the manufacturer's instructions and UL requirements.
- C. Provide all salt and filters for complete operating system.
- D. Provide factory start-up, commissioning, training, and service agreement proposal to owner.

3.4 VACUUM PUMP INSTALLATION

- A. A factory representative will be present to review installation and to start equipment.
- B. Extend vacuum discharge minimum 25 ft. away from building openings or fresh air intake.
- C. All equipment shall be installed per manufacturer's requirements. Maintain manufacturer's minimum clearances.
- D. Install all vibrating equipment on spring isolators with seismic restraints. Install flexible pipe connectors.

END OF SECTION

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED WORK

- A. General Conditions
- B. Special Conditions
- C. Supplementary General Conditions
- D. Architectural, Structural, Civil, Electrical and Mechanical Drawings & Specifications

1.2 SCOPE OF WORK

- A. The work covered by the Mechanical and Plumbing Sections of the Specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of all mechanical and plumbing work required in the Contract Drawings.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified in this Section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.
- C. The Contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field. The Contractor shall advise the Architect of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions, and the inclusion of all considerations for existing conditions.

1.3 PLANS AND SPECIFICATIONS

- A. These Specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
- B. If departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Architect for review. No departures shall be made without prior written acceptance of the Architect.
- C. The interrelation of the specifications, the drawings, and the schedules is generally as follows: The specifications determine the nature and setting of the materials, the drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.
- D. Should the drawings disagree in themselves or with the specifications, the contractor shall immediately notify the architect and shall perform and/or furnish the better quality or greater quantity of work or materials unless otherwise directed by the architect in writing. In case the specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on drawings govern scale measurements and large scale details govern small scale drawings. In case of

disagreement between specifications and drawings, see Division I of these specifications for clarifications.

- E. Items specifically mentioned in the specifications but not shown on the drawings and/or items shown on the drawings but not specifically mentioned in the specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

1.4 QUALITY ASSURANCE

- A. All work shall comply with the applicable rules of the following:
 - 1. 2018 International Building Code
 - 2. 2018 International Mechanical Code
 - 3. 2018 International Plumbing Code
 - 4. 2018 International Fire Code
 - 5. 2018 International Energy Conservation Code
 - 6. National Fire Protection Association Codes
 - 7. State Fire Marshall
 - 8. Latest edition of Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) Standards.
 - 9. All applicable city, county, state, and federal rules, codes, and ordinances.
- B. In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. None of the terms or provisions of this specification shall be construed as waiving any rules, regulations, or requirements of these authorities. The codes shall govern in case of direct conflict between the codes and the Drawings.

1.5 SUPERVISION

- A. A competent foreman or superintendent, initially approved by the Architect, shall be assigned to the project to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect. Architect's authorized representative and/or owner's observer shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's representative. Recommendations made by the observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect.

1.6 GUARANTEE

- A. The Contractor shall guarantee all materials and workmanship for a period of two (2) years after the final acceptance of work.

1.7 UTILITIES

- A. The contract documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such utility company charges and/or fees.

1.8 BUILDING CONSTRUCTION AND LAYOUT OF WORK

- A. It shall be the responsibility of the Contractor to consult the architectural and engineering drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.
- B. The Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and duct in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.
- C. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect, and he reserves the right to make any reasonable changes in the locations indicated without additional cost.

1.9 SHOP DRAWINGS AND BROCHURES

- A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of work. At least two weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data.
- B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.
- C. Each Shop Drawing shall indicate in the lower right hand corner and each Brochure shall indicate on the front cover the following: the Title of the Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract Drawings and/or Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:

- I. Shop Drawings: Drawings shall be drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by skilled technicians experienced in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.
 2. Brochures: Brochures shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space. Brochures not compiled in the manner described below shall be returned for resubmittal.
 3. Brochures submitted shall contain only information which is relevant to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.
- D. The submittal format shall follow the Specifications format with a submittal required for each section of Division 15. Each major category of equipment such as fans or pumps or air devices being submitted under a separate cover letter. The first submittal shall be accompanied by a three-ring hard back binder for the A/E to use in retaining copies of the submittals. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the A/E's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed manila index sheets also for the A/E's filing convenience.
- E. Submit six (6) copies of all Shop Drawings and Brochures for review and approval. One set will be retained by the Engineer, one set by the Architect for record purposes.
- F. Minimum size of submittal data shall be 8-1/2" x 11".
- G. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect reserved the right to require the Contractor to furnish items exactly as described in the Contract Documents.
- H. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they are not equal. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Architect based on the particular circumstances.
- 1.10 SUBSTITUTIONS
- A. The listing of product manufacturers, catalog numbers, etc., in the various sections of the specifications is intended to establish a standard of quality only, and is not intended to preclude open, competitive bidding. The Contractor may at his option submit substitute materials or methods which he feels are equal or superior to those specified. If the Contractor does submit alternate materials or methods, it shall be understood that the Contractor:
1. Has personally investigated the proposed substitute product and determined that it has all the same accessories and is equal or superior in all respects to the item specified.
 2. Will provide the same guarantee for the substitution that he would for that specified.

3. Has coordinated the installation of the equipment which he proposes to substitute with all other trades especially in regard to electrical requirements and to operating weights trades and includes the costs for any changes required for the work to be complete in all respects. The Contractor will prepare shop drawings where required by the Architect or where dimensions vary.
4. Waives any and all claims for additional costs related to the substitution.

1.11 SPARE PARTS DATA

- A. As soon as practicable after approval of materials and equipment, and, if possible, not later than one month prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the contract. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee specified.

1.12 RECORD DRAWINGS

- A. The Contractor shall keep a set of Drawings of the job, noting daily all changes made in the Drawings in connection with the final installation including exact dimensioned locations of all new and uncovered existing active and inactive utilities outside the building and shall turn over a clean, neatly marked set of sepia reproducible Drawings showing "as-built" work to the A/E for delivery to the Owner. All underground utilities and services and systems shall be accurately located by the Contractor and dimensioned on the "as-built" Drawings.

1.13 OPERATING AND MAINTENANCE MANUAL

- A. Prepare and submit to the Architect for delivery to the Owner an indexed manual with complete technical data for every piece of equipment and material installed under this contract.
 1. Complete mechanical submittals as approved by Architect.
 2. Manufacturer's installation instruction brochures.
 3. Manufacturer's local representative and/or Distributor's name, address and phone number.
 4. Manufacturer's operating and maintenance brochures.
 5. Manufacturer's internal wiring diagrams.
- B. This manual shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Sub-Contractors installing equipment represented in the brochure.
- C. Contents of the Manual shall be grouped in sections according to the various sections of the specifications and shall be listed in a Table of Contents.

PART 2 PRODUCTS

2.1 STANDARDS FOR MATERIALS

- A. All materials, in general, shall conform to the requirements of all agencies of publications hereinbefore specified under the paragraph QUALITY ASSURANCE and shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized testing agency indicating that the items have been tested in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

2.2 STANDARD PRODUCTS

- A. Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

2.3 MANUFACTURERS INSTRUCTIONS

- A. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor. If needed for proper installation, operation, or startup, the Contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Architect, he shall bear all costs arising in connection with the deficiencies.

2.4 RUST PREVENTION

- A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

2.5 STORAGE ON SITE

- A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is a suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

2.6 CAPACITIES

- A. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

2.7 NAMEPLATES

- A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

2.8 CONDITION OF MATERIAL AND APPURTENANCES

- A. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of substantial completion, shall be replaced by the Contractor without extra cost to Owner.

PART 3 EXECUTION

3.1 INSTALLATION OF SYSTEMS

- A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of system. No union will be required in welded lines or lines assembled with solder joint fittings, except at equipment items, machinery items, and other special pieces or apparatus. Companion flanges on lines at various items of equipment, machines and pieces of apparatus, shall serve as unions to permit removal of the particular items. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.

3.2 SPACE AND EQUIPMENT ARRANGEMENT

- A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of other equipment.
- B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly protected against damage.

3.3 PRECEDENCE OF WORK

- A. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades.

3.4 CUTTING AND PATCHING

- A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the observation of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written direction of the Architect.
- B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by the cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.
- C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.5 HOISTING, SCAFFOLDING, AND TRANSPORTATION

- A. The Contractor shall provide his own hoisting facilities to set his materials and equipment in place in the building, as indicated on drawings and for subsequent cleaning, testing, and adjusting.

- B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.6 CLEANING

- A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.
- B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

3.7 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

- A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Mechanical Drawings or specified in the Mechanical Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items' proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in Division 16 - Electrical. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in the Electrical Specifications and shown on the Electrical Drawings.

END OF SECTION

SECTION 230519 – MECHANICAL PIPING SPECIALTIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Escutcheons
- B. Strainers
- C. Dielectric Unions
- D. Air Vents
- E. Gaskets
- F. Bolts and Nuts
- G. Thermometers
- H. Pressure Gauges

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230529 - Supports, Anchors and Sleeves
- C. Section 230523 – General-Duty Valves For HVAC Equipment
- D. Section 232113 – Hydronic Piping

1.3 SUBMITTALS

- A. Submit manufacturer's product and dimensional data in accordance with Section 230500.

PART 2 PRODUCTS

2.1 ESCUTCHEONS

- A. Escutcheons shall be chrome plated sectional type. Solid type escutcheons with set screws shall be used when sectional type are not available of adequate size or where sectional type will not stay in place.

2.2 STRAINERS

- A. Strainers shall be Y-Pattern the same size as the pipe in which they are installed, threaded or flanged as indicated by pipe size. An arrow shall be cast on the side of the strainer to indicate the direction of flow. The basket shall be made of stainless steel or monel and shall provide a net free area through the basket of at least four times that of the pipe in which the basket is installed up to a maximum of 20 mesh.
- B. Strainers for water services shall have a cast iron body, an easily removable cover and a sediment screen. Cover shall have threaded 3/4" blow-off port.

- C. Strainers shall be RP&C, Hoffman, B&G, O.C. Keckley or approved equal.

2.3 DIELECTRIC UNIONS

- A. Unions shall be threaded or flanged type as dictated by the size of the piping. High temperature type insulating fittings shall be provided where required. Unions shall be EPCO or approved equal.

2.4 AIR VENTS

- A. All air vents required in the hot water circuit shall be of the ball and float type, cast iron body, stainless steel internals, Metraflex MV-15, Armstrong Pumps or V.O. Anderson 70A.
- B. Air vents shall be 3/4" screwed pattern valves suitable for 150 psig maximum working pressure. The vent shall be suitable for both hot and cold water service.

2.5 GASKETS

- A. Ring type gaskets shall be dimensioned to fit accurately within the bolt circle. Gaskets shall be 1/16" thick machine cut from Garlock No. 24 wire insertion red rubber sheet packing or approved equal. The inside diameter of such gaskets shall conform to the nominal pipe size, and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.
- B. Full face type gaskets shall be 1/16" thick machine cut from Garlock No. 24 wire insertion red rubber sheet packing. The inside diameter of the gaskets shall conform to the nominal pipe diameter. The outside diameter shall be such that the gasket extends outward to the outside perimeter of the flanges. The gasket shall have holes matching the drilling of the flanges.

2.6 BOLTS AND NUTS

- A. All bolts used for the fabrication of flanged joints shall be hex head carbon steel bolts, conforming to ASTM A- 307, Grade B, with semi-finished hexagon nuts of American Standard Heavy Dimensions. This bolting material shall have a tensile strength of 60,000 psi. All bolts and nuts must have full and clean cut threads.

2.7 THERMOMETERS AND THERMOMETER WELLS

- A. Provide 9 inch, aluminum case, brass stem, (aluminum stem in submersible wells), adjustable angle, mercury red reading type thermometers where shown on the drawings.
- B. Provide brass separable sockets of the correct length for the pipe size in which they are installed. Provide with extension necks when installed in insulated piping.
- C. Ranges shall be as follows:

Chilled Water	0°F to 100°F
Heating Water	0F to 200F
- D. Brass industrial test wells, 3/4" N.P.T., with cap and chain. Test wells shall be the correct length for the pipe size in which they are installed.
- E. Thermostats shall be Trerice, Weksler or approved equal.

2.8 PRESSURE GAUGES

- A. Provide 4-1/2" inch dial, bourdon type pressure gauges where shown on the drawings.
- B. Case shall be cast aluminum with black finish.
- C. Gauges shall have adjustable pointer and bronze movement with 1 percent accuracy over middle half of scale range and 1-1/2 percent accuracy over the balance of the range.
- D. Gauges shall have brass socket and be provided with brass pressure snubbers.
- E. Ranges shall be as follows:

Air Conditioning Water	0 to 100 psi
------------------------	--------------
- F. Pressure gauges shall be Trerice, Weiss, Weksler or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All strainers, air separators, suction diffusers, backflow preventers and pressure reducing valves shall be full line size unless noted otherwise.

3.2 ESCUTCHEONS

- A. Escutcheons shall be installed around all pipes passing exposed in finished areas through walls, floors and ceiling. Escutcheons shall be sized to fit tight around the outside of the pipe or pipe insulation.

3.3 STRAINERS

- A. Each control valve, and pressure reducing valve assembly regardless of its size shall be preceded by a strainer. The arrangement of these strainers shall be such that the screens may be removed for cleaning.
- B. Strainers shall be installed in piping systems wherever shown on the drawings and at such other points as may be required for the removal of foreign material from the piping system.
- C. All strainers shall be provided with full size blowdown ball valve with nipple and cap.

3.4 DIELECTRIC UNIONS

- A. Install dielectric unions or flanges where copper or brass piping connects to ferrous piping or equipment.

3.5 AIR VENTS

- A. Install automatic air vents at all high points in the air conditioning hot water systems with overflows piped to the nearest drain.

3.6 GASKETS

- A. Install gaskets between the flanges of all flanged joints. Use ring type gaskets for raised face flanges. Use full face gaskets for flat faced flanges.

3.7 THERMOMETERS AND THERMOMETER WELLS

- A. Install thermometers with scales upright and in a location where they may be easily read.
- B. Install thermometer wells where shown and where required to test and adjust the system.
- C. Replace any damaged thermometers. Do not repair.

3.8 PRESSURE GAUGES

- A. Provide gauge cocks or needle valves at all gauges suitable for the pressures and service involved.
- B. Replace any damaged gauges. Do not repair.

END OF SECTION

SECTION 230523 - VALVES FOR HVAC

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Ball Valves
- B. Butterfly Valves
- C. Balancing Valves

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 232113 - HVAC Piping Systems

1.3 SHOP DRAWINGS

- A. Submit product data in accordance with Section 15010.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Valves as manufactured by KITZ, Nibco, Apollo, Watts or approved equal are acceptable provided they meet or exceed these specifications.
- B. Provide valve types of same manufacturer throughout where possible.
- C. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
- D. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be of same make for all these services.

2.2 VALVE CONNECTIONS

- A. Provide valves suitable for connection to adjoining piping as specified for pipe joints. Use pipe size valves unless otherwise indicated.
- B. Provide threaded valves for pipe sizes 2 inches and smaller.
- C. Provide flanged valves for pipe sizes 2 1/2 inches and larger.
- D. Solder or screw to solder adaptors for copper tubing.
- E. Use valve body suitable for mechanical coupling jointed piping.
- F. Provide butterfly valves with full tapped lug bodies.

balancing valve is to be constructed with internal O-ring seals to prevent leakage around the rotating element. The balancing valves shall be supplied with performed polyurethane insulation, suitable for use on heating and cooling system.

- B. Automatic Balance Valves: Furnish threaded or flanged valves with cartridge, bronze or steel housing to match pipe material and pressure and temperature taps. Flow shall be accurate to a +/- 5% within a pressure range of 4 - 55 psi for Areas A,B,C,D & M; 2 - 30 psi for Areas E,F,G & H and 1 - 20 psi for Areas J & K. For flows below 30 gpm, combo valves may be used. Griswold Controls, Auto Flow or Hays valves are acceptable.

2.9 VALVE FEATURES

- A. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.
- B. Flanged valve ends comply with ANSI B16.1 (cast iron), ANSI B16.24 (bronze).
- C. Threaded valve ends comply with ANSI B2.1.
- D. Solder Joint valve ends complying with ANSI B16.18.
- E. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials; of standard alloy recognized in valve manufacturing that resist de-zincification.
- F. Butterfly valve designed for flow regulation and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220 psi. No leakage permitted under test.

2.10 VALVE OPERATORS

- A. Provide suitable handwheels for butterfly valves.
- B. For butterfly valves provide gear operators for sizes 8 inches and larger. For smaller sizes provide lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock nut and memory stop for throttling service.
- C. Provide valves located more than 7 feet from floor in equipment room areas with chain wheel operators. Extend chains to about 5 feet above floor and hook to clips arranged to clear walking aisles.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install ball or butterfly valves for shut-off and isolating service, to isolate equipment, part of systems, or vertical risers.
- C. All valves shall be located so that the bonnets can be removed.
- D. Provide brass tag for each valve labeling the fluid in the pipe, the area served, and the normal operating position.

END OF SECTION

SECTION 230529 – HANGERS & SUPPORTS FOR HVAC

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Pipe Hangers and Supports
- B. Duct Hangers and Supports
- C. Flashing for Mechanical Equipment
- D. Sleeving for Mechanical Equipment

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230529 - Supports, Anchors and Sleeves
- C. Section 232113 – Hydronic Piping
- D. Section 233113 – Ductwork

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with Section 230500.

1.4 REFERENCES

- A. Pipe Supports: ANSI B31.1, Power Piping.
- B. Duct Hangers: SMACNA Duct Manuals.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall be as manufactured by Grinnell, Elcen, Fee and Mason, Unistrut or approved equal.

2.2 INSERTS

- A. Malleable iron case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
- B. Size inserts to suit threaded hanger rods.

2.3 PIPE HANGERS AND SUPPORTS

- A. Hangers: Pipe sizes 1/2 inch to 1-1/2 inch: adjustable wrought steel ring.
- B. Hangers: Pipe sizes 2 inches to 4 inches and Cold Pipe sizes 6 inches and over: adjustable wrought steel clevis.

- C. Hangers: Hot Pipe sizes 6 inches and over: adjustable steel yoke and cast iron roll.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for Hot Pipe sizes 6 inches and over.
- E. Wall Support: Pipe sizes to 3 inches: cast iron hook.
- F. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for Hot Pipe sizes 6 inches and over.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.
- I. Steel Beam Clamps: Elcen Figure 33, Type 3 or approved equal.
- J. Expansion Anchors: Phillips Red Head or approved equal.
- K. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
- L. Design hangers to impede disengagement by movement of supported pipe.
- M. Provide copper plated hangers and supports for copper piping or two layers Scotch 33 PVC tape or equal.

2.4 HANGER RODS

- A. Provide cadmium plated steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.5 DUCT HANGERS AND SUPPORTS

- A. Hangers: Galvanized steel band iron or rolled angle and 3/8 inch rods.
- B. Wall Supports: Galvanized steel band iron or fabricated angle bracket.

2.6 FLASHING

- A. Steel Flashing: 24 gauge galvanized steel.
- B. Lead Flashing: 5 lb./sq.ft. sheet lead for water proofing, one lb./sq.ft. sheet lead for sound proofing.
- C. Safes: 5 lb./sq. ft. sheet lead or 8 mil thick neoprene.
- D. Caps: Steel, 22 gauge minimum, 16 gauge at fire resistance structures.

2.7 SLEEVES

- A. Pipes through Beams, Walls, Fire Proofing, Footings, and Floors: Form with galvanized steel pipe.
- B. Round Ducts: Form with 18 gauge galvanized steel.

- C. Rectangular Ducts: Form with 18 gauge galvanized steel.
- D. Size large enough to allow for movement due to expansion and to provide for continuous installation.
- E. Seal penetration with sealant per architectural specifications.

PART 3 EXECUTION

3.1 INSERTS

- A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch or ducts over 60 inches wide.
- C. Where concrete slabs form finished ceiling finish inserts, flush with slab surface.

3.2 PIPE HANGERS AND SUPPORTS

- A. All structures and appurtenances employed for the purpose of supporting the pipe and guiding it properly shall be carefully fabricated in such a manner as to preserve the true grade of the pipe without subjecting either the pipe or the supporting and guidance members to any undue strain.
- B. Support horizontal piping as follows:
- C. Space hangers and furnish rods as follows:

Nominal Pipe Size (in.)	Span (ft.)		Hanger Rod Diameter (in.)
	Steel	Copper	
1/2	5	5	3/8
3/4	6	6	3/8
1	7	6	3/8
1-1/2	9	8	3/8
2	10	9	3/8
3	10	10	1/2
4	10	10	5/8
6	10		3/4

- D. Support horizontal soil pipe with 5 feet maximum spacing between hangers.
- E. Support PVC pipe according to manufacturer's recommendation for the application intended, i.e., Elevated Temperatures.
- F. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.
- G. Place a hanger within one foot of each horizontal elbow.
- H. Use hangers which are vertically adjustable 1-1/2 inch maximum after piping is erected.

- I. Support piping at each change or direction, at ends of branches, at base and top of riser pipes and drops, and wherever necessary to prevent sag, bending or vibration, in addition to above-listed hanger spacing.
- J. Support vertical piping at every floor. Support vertical soil pipe at each floor at hub.
- K. Pipe hangers on insulated lines shall be sized to fit the outside of the insulation.
- L. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers, designed to support loads per ANSI B31.1.
- M. Where practical, support riser piping independently of connected horizontal piping.

3.3 DUCT HANGERS AND SUPPORTS

- A. Duct hangers and supports to be sized and spaced as per SMACNA requirements.

3.4 EQUIPMENT BASES AND SUPPORTS

- A. Provide for major equipment minimum four inch thick reinforced concrete house-keeping bases poured directly on structural floor slab pinned in place and extended 6 inches minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment. Coordinate with other trades.
- B. Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- C. Provide rigid anchors to ducts and pipes immediately after vibration connections to equipment.

3.5 PRIMING

- A. Prime coat non-galvanized steel hangers and supports.

3.6 FLASHING

- A. Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floor and roofs.
- B. Flash vent and soil pipes projecting 8 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inch minimum clear on sides with minimum 24 inch x 24 inch sheet size. For pipes through outside walls, turn flange back into wall and caulk.
- C. Flash floor drains over finished areas with lead 10 inch clear on sides with minimum 36 inch x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Provide curbs for mechanical roof installation 8 inch minimum high. Flash and counterflash with steel, soldered and waterproofed.
- E. Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to manufacturer's data for sound control.

3.7 SLEEVES

- A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

- B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.
- C. Where piping or ductwork passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.
- D. Install chrome plated escutcheons where piping passes through finished surfaces.
- E. Provide pipe sleeves for all mechanical piping.
- F. Size pipe sleeves to permit placing pipe and specified insulation material for pipes passing through concrete or masonry walls or concrete slabs.
- G. Sleeves for pipes through floor slabs standard weight galvanized steel pipe with top of sleeve projecting 2 inches above finished floor. For waterproof sleeves.
- H. Sleeves for pipe through walls standard weight galvanized steel pipe or 18-gauge galvanized sheet metal with ends flush with wall surface.
- I. Seal pipes passing through walls or slabs. Use mastic or oakum seal in the annular space in non-fire-rated walls; use Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal in the annular space in fire-rated walls or other envelopes.
- J. Seal exposed pipe passing through floor slabs with Dow- corning 3-6548 silicone RTV foam firestop sealant or equal and point with caulking compound. Strike off flush at top of sleeve.
- K. Insulated pipe shall be insulated in sleeves, caulked and pointed as above.
- L. Pipe and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided for roof penetrations.
- M. All piping shall be installed with due regard to expansion and contraction. Type of hanger, methods of support, location of supports, etc., shall be governed in part by this consideration.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 WORK INCLUDED

A. Testing, adjusting and balancing of the following systems:

1. Air Distribution Systems
2. Exhaust Systems
3. Air Handlers
4. Hydronic Systems
5. Domestic Hot Water Return System
6. Duct Leakage

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230900 – Instrumentation & Controls For HVAC
- C. Section 233417 – Utility Fans
- D. Section 233660 – Air Terminal Units
- E. Section 233713 – Diffusers, Registers & Grilles
- F. Section 237313 – Air Handling Units

1.3 REFERENCED STANDARDS

- A. Associated Air Balance Council, AABC National Standards.
- B. National Environmental Balancing Bureau, NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- C. Applicable SMACNA Standards.
- D. AMCA publication 203-A Guide to the Measurement of Fan System Performance in the Field.
- E. Air Distribution Council, ADC Test Code No. 106R3, Equipment Test Code.
- F. American Society of Heating, Refrigerating and Air Conditioning Engineers, ASHRAE Systems Volume chapter on Testing, Adjusting and Balancing and Sound and Vibration Control.

1.4 QUALITY ASSURANCE

- A. All work for the testing and balancing of the HVAC air distribution systems shall be done by an independent Testing and Balancing firm that specializes in and whose business is limited to the testing and balancing of heating, ventilating and air conditioning systems. The following companies shall be considered.
 - 1. Arizona Air Balance Company
 - 2. General Air Control
 - 3. Precisionaire of Arizona, Inc.
 - 4. TAB Technology, Inc.
- B. If requested, the test shall be conducted in the presence of the Architect and/or the Owner.
- C. The environmental systems including all equipment, apparatus and distribution systems shall be tested, adjusted and balanced in accordance with the latest edition of the AABC Procedural Standards for Testing, Adjusting and Balancing of Air Distribution and Hydronic Systems.
- D. Instruments used in all HVAC systems and equipment tests shall be as recommended by the AABC, ASHRAE, NEBB, or as approved by the Architect. Test instruments used shall be initially and periodically checked thereafter to verify their calibration accuracy.
- E. All test equipment shall be furnished by the Contractor and shall remain in his property. Any adapters such as "Pete's Plugs", pitot tube traverse connections, etc. shall be left in place and marked for future use.

1.5 SUBMITTALS

- A. Submit test reports in accordance with Section 230500.
- B. Specific procedures used in all tests shall be included in the test report. Contractor shall identify all equipment by the identification code as shown on the drawings.
- C. Data shall be on printed forms published by either AABC, NEBB, or the Contractor.
- D. The test report shall include as a minimum the following information and data:
 - 1. Motors:
 - Equipment number
 - Manufacturer
 - Model or serial number
 - Frame size
 - Rated horsepower
 - Rate rpm
 - Corrected full load amperage
 - Measured amperage and voltage
 - Calculated bhp
 - Measured rpm
 - Sheave size, type and manufacturer
 - 2. Fans:
 - Equipment number
 - Manufacturer
 - Model or serial number

- Rated cfm
 - Rated rpm
 - Rated pressures
 - Measured cfm
 - Measured rpm
 - Measured pressures
 - Pulley size, type and manufacturer
 - Belt size and quantity
3. Duct Leakage Testing:
Dimensioned drawing of duct section tested
Test pressure
Actual leakage (show calculations)
Allowable leakage (show SMACNA Leakage Table and calculated duct surface area)
Date of test
4. Terminal Units:
Equipment number
Manufacturer and model
Maximum cfm
Minimum cfm
Heating Water gpm
5. Diffuser, Registers and Grilles:
System identification
Grille number
Grille or diffuser manufacturer
Manufacturer's model number
ADC flow factor
Instrument to be used with ADC flow factor
Grille size
Design velocity
Design cfm
Final measured velocity
Final measured cfm
- E. All reports shall be certified by the Testing and Balancing Contractor that the methods used and the results achieved are as specified. In addition, each individual reporting form submitted must bear the signature and the Technician.
- 1.6 GUARANTEE
- A. The test and balance firm shall include an extended warranty of 90 days, after the submittal of the test and balance report, during which time the Architect, at his discretion, may request a recheck or resetting of any outlet, supply air fan, exhaust fan, or any other item listed in the test report. The firm shall provide technicians to assist the Architect making any tests he may require during this period of time.

PART 2 PRODUCTS

Not applicable for this section.

PART 3 EXECUTION

3.1 INSPECTION

- A. The Testing and Balancing Contractor shall act as an authorized inspection firm responsible to the Architect. He shall review the HVAC design drawings and shop drawings prior to fabrication and installation of the HVAC systems to insure that all of the necessary balancing equipment required to balance these systems is shown.

3.2 PREPARATION

- A. Coordinate Schedules with the Test and Balancing Engineer and provide sufficient time before final completion of work so that testing and balancing can be accomplished. Provide all labor and tools to make corrections to the system when required to balance the system without undue delay to the Test and Balancing Contractor. Put all equipment into full operation and continue it in operation during each working day of testing and balancing. No test and balancing work shall start until all of the air handling equipment has new filters installed. The Test and Balancing Engineer shall be kept informed during the construction of the project of major changes made to the HVAC system. Provide the Test and Balancing Contractor with one (1) set of shop drawings on all equipment which he will be required to work on when balancing the HVAC system.
- B. Shop drawings shall be submitted to the Test and Balancing Contractor. The Test and Balancing Contractor will, during the construction of the HVAC system, make job site inspections to familiarize himself with the project and shall report to the Architect items installed incorrectly or not installed in accordance with the contract drawings and specifications.
- C. Work shall not begin until all systems which are to be tested have been completed and are in full working order. Put all systems and equipment into full operation and continue the operation of all equipment during each working day of the testing and balancing work.

3.3 AIR DISTRIBUTION SYSTEMS TESTING AND BALANCING

- A. Utilizing the latest issue of design documents, compare the installed equipment to the design and check for completeness of the installation.
- B. All medium pressure ductwork between VAV air handlers and terminal units shall be leak tested per SMACNA standard. The test pressure shall be equal to the duct construction pressure classification and the leakage classification shall be as shown on the Leakage Table in the SMACNA HVAC Air Duct Leakage Test Manual. Coordinate testing sections and submit drawings, calculations, Leakage Table and test data for each section of ductwork.
- C. The system and air outlet air quantities shall be balanced to the values indicated on the drawings.
- D. The grille manufacturer's outlet flow factors as determined by the ADC test code and recommended procedure for testing air outlets shall be used.
- E. Pre-balance equipment check:
 - 1. Check fan housing, ducts, duct elbows, coils, louvers, etc., to insure they are clean and free of foreign material.
 - 2. Check filters to insure that they are clean and in place.
 - 3. Examine drivers for proper belt tension and alignment.
 - 4. Check fan and motor lubrication.

5. Coordinate with Electrical Contractor to verify correct motor overload protectors.
 6. Coordinate with HVAC Control Contractor for proper operation and position of operating dampers.
 7. Check fans for proper rotation.
- F. Pre-balance System Check:
1. Verify installation of all required balancing dampers. Set all systems dampers in their open position.
 2. Check for air leaks at the fan and the system ductwork. Coordinate with the Contractor for repair of leaks.
 3. Position all building doors and windows (if a part of system design) in their normal position.
 4. Check air temperature to insure required air temperature delivery.
- G. Air Handling Equipment Balance:
1. Check motor amperage and voltage to insure motor is not being overloaded.
 2. Measure and set minimum outdoor air quantity where applicable.
 3. Determine the volume of air being delivered by the fan. Adjust the fan speed, if belt-driven, or the dampers in the system, if direct-driven, to increase or decrease the flow required. If the speed is increased, or the flow changes due to a damper adjustment, insure that the motor is not overloaded.
 4. Check fan and motor speed, no-load amperage, operating amperage and voltage. Calculate brake horsepower.
 5. Take fan static pressure readings.
 6. Variation of air flow for all modes of operation from the design values shall be within +10 percent of design values.
- 3.4 WATER DISTRIBUTION SYSTEM BALANCING AND TESTING
- A. Utilizing the latest issue of design documents, compare the installed equipment to the design and check for completeness of the installation.
- B. Pre-balance Equipment Check:
1. Check to insure that automatic fill valves are functioning properly.
 2. Check pump and motor lubrication, and overload protectors for proper size.
 3. Check pump for proper rotation.
- C. Pre-balance System Check:
1. Set all valves in their wide open position.

2. Check system strainers for cleanliness.

D. Pump Testing and Adjustment:

1. Determine pump impeller size by plotting no-flow pump differential pressure on pump curve.
2. Determine water flow by plotting full-flow pump differential pressure on pump curve. Adjust flow to approximately 110 percent of design.
3. Record motor voltage and amperage and calculate brake horsepower.

E. Water System Balancing:

1. Determine and set flow rates to insure proper GPM and water supply temperature.

3.5 OTHER EQUIPMENT TESTS

- A. All equipment installed shall be tested, adjusted, and reported upon unless stated otherwise. The equipment discussed herein is not necessarily all of the equipment requiring testing.

B. Fans:

1. Record nameplate data.
2. Check operation of backdraft dampers.
3. Check belt alignment and belt tension.
4. Measure current, voltage, and speed (rpm).

END OF SECTION

SECTION 230700 - HVAC INSULATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Insulation of Chilled and Heating Water Piping
- B. Insulation of Condensate Piping

1.2 RELATED WORK

- A. Section 230500 – Common Work Results For HVAC
- B. Section 232113 - Hydronic Piping

1.3 QUALITY ASSURANCE

- A. All insulation materials required for piping, and mechanical equipment, etc. shall be furnished and installed under this contract. The execution of the work shall be by approved insulation contractor in strict accordance with the best practice of the trade and the intent of this Specification.
- B. It is mandatory that all insulation be applied in a neat and workmanlike manner. Contractor shall be required to remove and replace all insulation not applied in strict accordance with manufacturer's specifications or not presenting a neat finished appearance.
- C. All insulation on indoor work shall have composite (insulation, jacket or facing, and adhesive used to adhere jacket or facing to the insulation) fire and smoke hazard Ratings, as tested by procedure ASTM E-84, NFPA 255 and UL 73 not exceeding Flame Spread of 25, Fuel Contributed of 50 and Smoke Developed of 50. Accessories, such as adhesives, mastics, cements, tapes and cloths for fittings shall have component ratings as listed above.
- D. Insulation shall be continuous through wall, floor and ceiling openings and sleeves.
- E. Specified mastics, adhesives and coatings shall be applied in strict accordance with manufacturer's instructions, including recommended coverages.

1.4 SUBMITTALS

- A. Submit materials and installation instructions in accordance with Section 230500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Owens-Corning, Knauf, Johns Manville, Certain-Teed, Govain, Benjamin Foster are acceptable provided they meet or exceed these specifications.

2.2 PIPING

A. Piping:

1. Insulation thickness - Fiberglass pipe covering.

PIPING TYPE	PIPE SIZE	INSULATION SIZE
Heating Water Supply & Return	1-1/4" & under	1-1/2"
	1-1/2" & up	2"
Chilled Water Supply & Return	1-1/4" & under	1/2"
	1-1/2" & up	1"
Condensate Piping	All sizes	1/2"

2. All fiberglass pipe insulation shall be nominal 5 pcf density.
3. Insulation jacket shall be factory applied white All Service Jacket (ASJ), with factory supplied self-sealing laps.
4. Refrigerant and condensate piping may be insulated with 1/2" thick expanded rubber insulation at the contractor's option.
5. Fittings, Valves and Flanges:
- a. Where manufactured, factory premolded fittings (of the same material and thickness as the pipe insulation) shall be used for all fittings, flanges and valves.
 - b. Where premolded insulation fittings are not manufactured, all fittings, flanges and valves shall be insulated with mitered segments of nominal 5 lb. density fiberglass pipe covering. Hot Service Finish: embed a 20 x 20 weave white glass reinforcing cloth between two 1/16 inch coats of Benjamin Foster 30-36. The glass cloth and second coat shall overlap adjacent covering by at least two inches. Cold Service Finish: same as above except use Benjamin Foster 30-35.
 - c. Insulation for removable flanges of pipe strainers shall be fabricated with built-up sections of Fiberglass pipe covering, so arranged as to facilitate servicing of the strainer. Applications for cold services shall be complete with vapor seals.
6. Insulation on pipes shall be protected by saddles from hangers, guides, and rollers.

PART 3 EXECUTION

3.1 PREPARATION

- A. Do not install covering before piping and equipment has been tested and approved.
- B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 INSTALLATION

- A. Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed.
- B. Insulate fittings and valves. Do not insulate unions, flanges, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material troweled on bevel.

- C. Finish insulation neatly at hangers, supports and other protrusions.
- D. Locate insulation cover seams in least visible locations.
- E. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.
- F. Provide pipe markers as specified in Section 232113.

END OF SECTION

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Fundamental commissioning shall be provided for all air handling units, terminal units, exhaust fans, and fume hood controls.

1.2 TESTING, ADJUSTING, & BALANCING

- A. All mechanical equipment and plumbing circulation pumps shall be balanced by an AABC Certified testing & balancing contractor in accordance with AABC standards and methods. In addition, all temperature sensors and other sensors shall be calibrated. Submit final typed air balance report on AABC standard forms for approval.

1.3 COMMISSIONING PLAN

- A. All mechanical equipment shall be commissioned under this contract with all fees paid by the contractor. An AABC, NEBB, or BCA certified commissioning authority or the engineer of record can be contracted to perform the functional performance testing and documentation on the mechanical equipment and controls based on the sequence of operation described in the drawings. A Preliminary Commissioning Report shall be submitted to the general contractor, building owner, or engineer of record for review and to the code official if requested. This report shall identify any deficiencies found during the testing that have not been corrected along with the recommended corrective measures. This report shall also identify testing that could not be performed due to climatic conditions. A final Commissioning Report shall be issued after project completion in a timely manner.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Prepare and submit for delivery to the tenant an indexed manual for each piece of equipment or material installed under this contract with the following data and per specifications:
 1. Name and address of at least one service agency.
 2. Complete mechanical equipment submittals data approved by the Architect/Engineer.
 3. Manufacturer's installation instructions.
 4. Manufacturer's operation and maintenance manuals.
 5. HVAC system controls maintenance and calibration information.
 6. Testing, Adjusting, & Balancing Report
 7. Commissioning Report

END OF SECTION

SECTION 230900 – INSTRUMENTATION & CONTROL FOR HVAC

PART 1 GENERAL

1 SUMMARY

- A Work specified under this section shall comply to Pima Community College Manual of Design and Specifications Section 230923 dated 04/2019 (30 pages).
- B This Section includes control equipment for HVAC systems and components, including control components for fans and valves not supplied with factory-wired controls and other equipment specified in the controls sequence.
- C Drawings and general provisions of contract, including general and supplementary conditions and Division 1 apply to work specified in this section.

2 SUBMITTALS

- A Product Data: For each control device indicated.
- B Shop Drawings:
 - 1 Schematic flow diagrams.
 - 2 Power, signal, and control wiring diagrams.
 - 3 Details of control panel faces.
 - 4 Valve schedule.
 - 5 DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
 - 6 Control System Software: Schematic diagrams, written descriptions, and points list.
 - 7 Graphic Displays: Graphic displays of each page shall be submitted for approval.
- C Software and firmware operational documentation.
- D Field quality-control test reports.
- E Operation and maintenance data.

3 QUALITY ASSURANCE

- A All controllers and devices shall meet the requirements of ASHRAE BACnet Standard 135 for communication protocol at all levels.
- B Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an OSHA Nationally Recognized Testing Laboratory, and marked for intended use.

PART 2 PRODUCTS

1 MANUFACTURERS

- A In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1 Available Manufacturers: Subject to compliance with requirements, manufacturers

offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

- 2 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2 CONTROL SYSTEM

A Manufacturers:

- 1 Delta Controls Inc. (BACnet)

B Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and programmed to control mechanical systems. An existing operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics. Provide new graphics specifically for this project.

3 DDC EQUIPMENT

A Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

- 1 Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.

2 Stand-alone mode control functions operate regardless of network status. Functions include the following:

- a Global communications using ASHRAE BACnet protocol.
- b Discrete/digital, analog, and pulse I/O using standard BACnet objects.
- c Monitoring, controlling, or addressing data points.
- d Software applications, scheduling, and alarm processing.
- e Testing and developing control algorithms without disrupting field hardware and controlled environment.

B Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

- 1 Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.

2 Stand-alone mode control functions operate regardless of network status. Functions include the following:

- a Global communications using ASHRAE BACnet protocol.
- b Discrete/digital, analog, and pulse I/O using standard BACnet objects.
- c Monitoring, controlling, or addressing data points.

- 3 Local operator interface provides for download from or upload to operator workstation.
 - C I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - 1 Binary Inputs: Allow monitoring of on-off signals without external power.
 - 2 Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - 3 Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 - 4 Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
 - 5 Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
 - 6 Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 - 7 Universal I/Os: Provide software selectable binary or analog outputs.
 - D Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection with hi/lo disconnects; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1 Output ripple of 5.0 mV maximum peak to peak.
 - 2 Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3 Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
 - E Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1 Minimum dielectric strength of 1000 V.
 - 2 Maximum response time of 10 nanoseconds.
 - 3 Minimum transverse-mode noise attenuation of 65 dB.
 - 4 Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- 4 ELECTRONIC SENSORS
- A Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
 - B Thermistor Temperature Sensors and Transmitters:
 - 1 Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
 - 2 Wire: Twisted, shielded-pair cable.
 - 3 Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 - 4 Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a Set-Point Adjustment: Concealed.
 - b Set-Point Indication: Concealed.
 - c Thermometer: Concealed.
 - d Override Button: Exposed.
 - e Communication: LAN BACnet port.

5 Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C RTDs and Transmitters:

- 1 Accuracy: Plus or minus 0.2 percent at calibration point.
- 2 Wire: Twisted, shielded-pair cable.
- 3 Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
- 4 Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
- 5 Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a Set-Point Adjustment: Concealed.
 - b Set-Point Indication: Concealed.
 - c Thermometer: Concealed.
 - d Override Button: Exposed.
 - e Communication: LAN BACnet port.

6 Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

5 STATUS SENSORS

- A Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- B Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- C Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- D Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

6 ACTUATORS

- A Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1 Manufacturers:
 - a Belimo Aircontrols (USA), Inc.
 - 2 Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 3 Coupling: V-bolt and V-shaped, toothed cradle.
 - 4 Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 5 Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 - 6 Power Requirements (Two-Position Spring Return): 24-V ac.
 - 7 Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 8 Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

9 Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).

7 CONTROL VALVES

- A Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B Valves shall be 2-way or 3-way as indicated on the plans.
- C All reheat coil valves shall be pressure independent control valves with integrated flow limiter and 24V modulating actuator and manufactured by Danfoss or Belimo.
- D All air handler valves shall be pressure independent energy valves with integrated flow limiter, 24V modulating actuator, temperature sensors, controller, and energy (BTU) monitor.

8 FUME HOOD CONTROLLERS

- A All fume hoods shall be provided with a packaged controller equal of Phoenix, Antec, or TSI.
- B Controls shall include hood sash position sensor, exhaust duct airflow monitor, exhaust duct control damper or venturi valve, and controller to operate room terminal units with reheat coils. See plans, control diagram, and sequence of operation for additional requirements.

9 EXHAUST FAN CONTROLLERS

- A All exhaust fans shall be provided with fan controller to modulate the VFD based on exhaust duct static pressure sensor and modulate the bypass damper to maintain discharge velocity.
- B Coordinate all installation, programming, and commissioning requirements with manufacturer. Provide full BACnet communication and display all points.

10 AIR HANDLER SENSORS

- A All air handlers are provided with factory installed and wired VFDs, damper actuators, and sensors.
- B Coordinate all installation, programming, and commissioning requirements with manufacturer. Provide full BACnet communication and display all points.

11 CONTROL CABLE

A Wide Area Network (WAN)

- 1 Coordinate WAN connection location and type with **Pima Community College (PCC)**. Coordinate proper addressing of network and objects numbers with **PCC**. Provide all cabling from main controller to **PCC** WAN connection.
- 2 Provide BACnet IP Router for connection to the WAN.
- 3 Provide surge protection circuits at each end of communication links between equipment at all building penetrations.

B Local Area Network (LAN)

- 1 The LAN shall support BACnet/Ethernet or BACnet/IP and shall share a common network number as defined in BACnet. Network numbers shall be defined and coordinated with PCC.

- 2 The LAN shall be continuous, hard-wired media. Power-line communication shall not be acceptable for communications.
- 3 The minimum data transmission speed from the Building Control Units shall be 10 Mbps or greater. The minimum speed from the Local Control Units shall be 56,600 baud.
- 4 All LAN cabling shall be in EMT conduit. Cabling above lay-in ceilings can be plenum rated cable secured to ductwork or building structure.

C Electrical Wiring

1. All wire, wiring and conduit required for the operation of the controls shall be the responsibility of this contractor and shall be installed as described and in accordance with the requirements of acceptable local governing building codes and those defined by the National Electrical Code (NEC).
2. This contractor shall be responsible for supplying complete and approved wiring diagrams and installation supervision of the wiring of the control system and shall perform all necessary set-up and calibration labor.
3. Starters, furnished in other sections of these specifications, shall be installed under the electrical specifications, but all low voltage wiring from auxiliary contacts or relays shall be under this section of the specifications.
4. All wiring, including Class 2 signal wiring, shall be installed as a Class 1 electrical system as defined by the NEC.
5. All conduit shall be 1/2 inch size minimum. EMT conduit may be used for mechanical rooms and finished spaces. EMT installation shall meet local governing building codes. Rigid conduit will be used for underground or exterior building circuits or where specifically noted.
6. All wiring in exposed areas of mechanical rooms and finished spaces shall be run in EMT conduit. All Class 1 power wiring shall be run in conduit in exposed and concealed areas. EMCS bus wiring must not be run in the same conduit line voltage wiring (30 VAC or above) or wiring that switches power to highly inductive loads (contactors, coils, motors, generators, etc.). Electronic control circuit wiring shall not be run in the same conduit containing other electrical wiring.
7. Low voltage wiring above lay-in ceilings may be exposed cabling secured to building structure or ductwork.

PART 3 EXECUTION

1 INSTALLATION

- A Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.
 - 1 Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- B Install labels and nameplates to identify control components.
- C Install hydronic instrument wells, valves, and other accessories according to Division 23.

2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A Install raceways, boxes, cabinets, wire and cable according to Electrical Specifications.
 - B Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
 - C Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- 3 FIELD QUALITY CONTROL
- A Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
 - B Perform the following field tests and inspections and prepare test reports:
 - 1 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2 Test and adjust controls and safeties.
 - 3 Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4 Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5 Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6 Test each system for compliance with sequence of operation.
 - 7 Test software and hardware interlocks.
 - C DDC Verification:
 - 1 Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 2 Check instruments for proper location and accessibility.
 - 3 Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4 Check instrument tubing for proper fittings, slope, material, and support.
 - 5 Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6 Check temperature instruments and material and length of sensing elements.
 - 7 Check control valves. Verify that they are in correct direction.
 - 8 Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 - 9 Check DDC system as follows:
 - a Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c Verify that spare I/O capacity has been provided.
 - d Verify that DDC controllers are protected from power supply surges.
 - D Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
- 4 DEMONSTRATION

- A Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.
- B Coordinate content of training with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.
- C Develop a learning objective and teaching outline. Include a description of specific skills and knowledge that participant is expected to master. Include instruction for the following:
 - 1 Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.
 - 2 Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.
 - 3 Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.
 - 4 Operations: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.
 - 5 Adjustments: Include alignments and checking, noise, vibration, economy, and efficiency adjustments.
 - 6 Troubleshooting: Include diagnostic instructions and test and inspection procedures.
 - 7 Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
 - 8 Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.
- D Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1 Schedule training with Owner with at least seven days' advance notice.
- E Evaluation: At conclusion of training, assess and document each participant's mastery by use of a demonstration performance-based test.
- F Record demonstration and training on videotapes. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

END OF SECTION

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Heating Hot Water Piping Systems
- B. Chilled Water Piping Systems
- C. Condensate Piping Systems
- D. Pipe Markers

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230523 – General-Duty Valves For HVAC
- C. Section 230529 – Hangers & Supports for HVAC Piping & Equipment
- D. Section 230700 – HVAC Insulation
- E. Section 233660 – Air Terminal Units
- F. Section 237313 – Air Handling Units

1.3 SUBMITTALS

- A. Submit product data on materials to be used in accordance with Section 230500.

1.4 QUALITY ASSURANCE

- A. Welding materials and labor to conform to ASME Code and applicable state Labor Regulations.
- B. Use welders fully qualified and licensed by state authorities.
- C. All piping shall be manufactured in the United States.

1.5 REFERENCES

- A. ANSI/ASTM A53 - Pipe, steel, Black and Hot-Dipped Zinc- Coated, Welded and Seamless.
- B. ANSI/ASME B16.3 - Malleable - iron, Black or Galvanized, Threaded Fittings
- C. FS WW-P-521 - Pipe Fittings, Flange Fittings, and Flanges: Steel and Malleable Iron (Threaded and Butt Welding), Class 150.
- D. ANSI/ASTM B306 - Copper Drainage Tube (DWV)
- E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings (DWV)

1.6 PIPING, GENERAL

- A. The accompanying drawings are intended for the contractor's guidance, and he shall verify their accuracy and immediately notify the Architect of any discrepancies so that such discrepancies may be resolved prior to actual fabrication or installation of work. Minor changes in position of piping as necessary to meet job conditions shall be anticipated by the contractor and shall not be made the basis for change order. Changes affecting accessibility to or clearance about equipment or accessories shall be promptly communicated to the Architect.
- B. Sizes and arrangement of piping shall be as shown on the drawings. In case of inconsistency of details for final connections, resulting in conflict, such conflict shall be resolved by the Architect.
- C. Attention is called to the inclusion of the "piping diagrams" in the working drawings. These piping diagrams are not for the purpose of giving physical dimensions or locations but rather to make clear the interconnections, by the piping, of the various units of the process. If an item is shown on either the piping diagram or the piping detail drawings, but not on both, it will be assumed that the Contractor has included such item in his estimate of the cost of the work and that he shall install same.

PART 2 PRODUCTS

2.1 CHILLED AND HEATING WATER PIPING

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black. Fittings: ANSI/ASME B16.3, malleable iron, or ASTM A234, forged steel welding type. Joints: Threaded for pipe two inches and under; ANSI/AWS D1.1, welded, for pipe over two inches.
- B. Piping 2-1/2" and Smaller can be Copper Tubing: ASTM B88, Type L hard drawn. Fittings: ANSI/ASME B16.29, wrought copper. Joints: ANSI/ASTM B52, solder, Grade 95TA.
- C. Above Ground Steel Pipe can use Couplings: ASTM A47 malleable iron or ASTM A536 ductile iron ANSI/AWWA C151/A21.51 Class 53, with Butyl gasket, UL listed.

2.2 CONDENSATE DRAIN PIPING

- A. Copper Tubing: ASTM B88, Type M, hard drawn. Fittings: ANSI/ASME B16.29, wrought copper. Joints: ANSI/ASTM B52, solder, Grade 95TA.

2.3 UNIONS AND COUPLINGS

- A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
- B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- D. Grooved End Pipe: Malleable iron or ductile iron split couplings with ASTM D-2000 sealing gasket, bolts and nuts; galvanized couplings for galvanized pipe.

2.4 VALVES

- A. Valves shall be in accordance with Section 230523.

2.5 PIPE MARKERS

- A. Provide pipe markers for all chilled and heating water piping exposed or above lay-in ceilings.
- B. Pipe markers shall be plastic snap-around type equal of Seton Setmark. Adhesive or stenciled pipe markers are not acceptable for interior installation.
- C. Exterior pipe markers shall be stencil painted markers.
- D. All pipe markers shall meet ASME/ANSI Standard A13.1 for pipe identification.
- E. Pipe markers to include directional arrow for direction of fluid flow.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Grade piping to facilitate drainage.
- B. Install piping with careful regard to expansion.
- C. All piping shall be run straight and parallel with adjacent walls and shall present a uniform and neat appearance.
- D. Make connections to equipment with unions or flanges.
- E. On closed systems, equip all low points with 3/4 inch drain valves and hose ends. Provide air vents at high points.
- F. Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting.
- G. Group piping whenever practical at common elevations.
- H. Provide clearance for installation of insulation and for access to valves, air vents, drains and unions.

3.2 PIPE MARKERS

- A. Identify piping, flow direction and contents as specified. For insulated pipe, identify in clear view on insulation.
- B. Install all pipe markers at maximum 10 foot intervals and within 5 feet of a floor, ceiling, or wall penetration.

3.3 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, inside and outside, before assembly.
- C. Remove rust or foreign material from pipe and fitting materials.

- D. Clean the ends of copper pipe and the inside of soldered fittings with emery cloth, metallic wool, or other suitable means prior to joining.

3.4 STEEL PIPE CONNECTIONS

- A. Use galvanized fittings, flanges and couplings for galvanized pipe.
- B. Screw joint steel piping up to and including 2 inches. Weld piping 2-1/2 inch and larger, including branch connections.
- C. Die cut screwed joints with full cut standard taper pipe threads using linseed oil. Make joints using non-toxic joint compounds applied to male threads only.
- D. Use main sized saddle branch connections for directly connecting branch lines to mains in steel piping. Do not project branch pipes inside the main pipe.
- E. Joints for Threaded End Pipe: Coated with pipe lubricant compound.
- F. Flanged Connections: Tighten nuts uniformly. Bolts shall not protrude more than 1/4" through the tightened nut.

3.5 TESTING

- A. Test piping systems prior to the application of insulation.
- B. For piping installed in concealed spaces or buried, test piping before system is concealed or backfilled.
- C. Test water piping to a hydrostatic pressure of 1-1/2 times normal operating pressure, 100 psig minimum, for a continuous period of not less than eight hours. During this time carefully inspect the system for leaks. If necessary repair leaks in a manner acceptable to the architect and test again until no leakage is detected.
- D. After testing, and whenever conditions permit, operate systems at normal operating pressure and temperature for not less than five consecutive days. The piping systems must remain free from leaks during this period.
- E. Test using higher pressures if required by authorities having jurisdiction.

3.6 WATER TREATMENT

- A. Coordinate all water treatment with PCC central plant operators and PCC chemical treatment contractor.
- B. After piping has been tested leak free, flush the system clean with a liquid alkaline cleaner formulated with soaps, synthetic detergents and dispersants. Apply as per manufacturer's instructions.
- C. Provide a nonchromate and organic corrosion inhibitor boron nitrite to system before start-up of system. Apply with by-pass feeder as per manufacturer's instructions.

END OF SECTION

SECTION 233113 - DUCTWORK

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Ductwork and Plenums
- B. Fasteners
- C. Sealants
- D. Duct Cleaning
- E. Testing

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230529 – Hangers & Supports for HVAC
- C. Section 230593 – Testing, Adjusting & Balancing For HVAC
- D. Section 233114 – Duct Lining
- E. Section 233300 – Air Duct Accessories
- F. Section 233423 – HVAC Power Ventilators
- G. Section 233713 – Diffusers, Registers & Grilles

1.3 REFERENCE STANDARDS

- A. Fabricate in accordance with the most recent edition of SMACNA HVAC Duct Construction Standards.
- B. Construct ductwork to NFPA 90A, Air Conditioning and Ventilating Systems, NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

1.4 DEFINITIONS

- A. Duct Sizes: Dimensions shown on the Drawings are sheet metal sizes.
- B. Low Pressure or Velocity: All return, transfer, and exhaust ductwork and all supply ductwork from all constant volume air handlers and fan coils, and downstream of terminal units to air devices.
- C. Medium Pressure or Velocity: All supply air ductwork from variable air volume air handlers to terminal unit. All exhaust ductwork from exhaust fan to air valves.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by the following manufacturers meeting these specifications are acceptable.
- B. Flexible ducts manufactured by Thermaflex, Wire Mold, Certain Tweed and ATCO are acceptable.
- C. Round and oval ductwork manufactured by United Sheet Metal, Semco, General Metals, Spiro-Fab and Metal Manufacturing are acceptable.

2.2 MATERIALS

- A. Galvanized Ductwork: Galvanized steel lock forming quality having zinc coating of 1.25 ounces per square foot for each side per ASTM A525 G90. All ductwork to be galvanized unless otherwise noted.
- B. Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.
- C. Sealant: Water resistant, fire resistive, compatible with mating materials. All duct tapes and mastics shall be listed and labeled in accordance with U.L. 181.
- D. Flexible Ducts: UL 181 Class 1 airduct consisting of inner vapor barrier supported by a helically wound steel wire; wrapped with 1-1/2" thick flexible fibrous glass insulation, enclosed by a reinforced foil outer jacket. Ductwork shall be a factory fabricated assembly with hanger tab support system equal to CertainTeed Certaflex 25.
- E. Medium Pressure Flexible Fibrous Glass Ducts: Similar to low pressure flexible duct with velocity rating of 6000 fpm and positive pressure rating of 10 inches w.g., equal to Thermaflex M-KC.
- F. Fume Hood Exhaust Ductwork: Type 316 stainless steel, minimum 26 gauge, round spiral, all welded construction. Joints to be constructed with process equal to thermofit wrap around Duct Bands manufactured by Raychem.

2.3 FABRICATION

- A. The contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field prior to fabricating ductwork. The contractor shall advise the Architect of any discrepancy prior to fabrication.
- B. Size round ducts installed in place of rectangular ducts from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.
- C. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.
- D. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on center line. Where not possible and where rectangular elbows used, provide single thickness type turning vanes.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Maximum divergence upstream of equipment to be 30 degrees and 45 degrees convergence downstream.
- F. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate, or sag. Seal all duct joints and connections with "hard cast" tape sealant or equal as ducts are being assembled.

- G. Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two ducts maintaining original duct area.
- H. For fume hood exhaust ductwork tack weld connections all around minimum of four (4) locations at 90 degree intervals. Install 3" wide strip of Raychem heat shrink joint seal according to manufacturer's instructions. No screws, bolts or rivets accepted.

2.4 DUCT GAUGES AND REINFORCEMENT

- A. Provide minimum duct wall thickness and reinforcement as required by the latest edition of the SMACNA HVAC Duct Construction Standards.
- B. All medium pressure supply ductwork from the variable air volume air handler to the terminal units shall be constructed for 4" w.c. pressure classification with seal class A. All other ductwork shall be constructed for 2" w.c. pressure classification with seal class C unless noted otherwise.
- C. All exhaust ductwork to be constructed for negative 4"w.c. pressure classification with fittings minimum 2 gauges heavier construction.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- B. Clean duct system with forced air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.
- C. Seal all transverse joints with Hard Cast or equivalent.
- D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- E. At each point where ducts pass through partitions, seal joints around duct with non-combustible material. Provide sheet metal closure around opening when exposed.
- F. Paint all exposed ductwork as directed by architect.
- G. All fume hood ductwork shall have long radius elbows, wye fittings, cleanouts, and blast gates as shown on the plans.

3.2 TESTING

- A. All medium pressure ductwork shall be leak tested per Section 230593. Blank-off ductwork and make necessary repairs to the ductwork per this section until acceptable leakage is demonstrated.

END OF SECTION

SECTION 233114 - DUCT LINING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Duct Lining

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 233113 – Ductwork

1.3 QUALITY ASSURANCE

- A. Uniform Mechanical Code and Local Codes
- B. ASTM E-84 and NFPA 90A for Fire Hazard Classification
- C. ASTM D 903 for Adhesive Bonds

1.4 REFERENCE STANDARDS

- A. TIMA AHC-101
- B. ASTM C-423-77 for Sound Absorption
- C. ASTM C-177 for Thermal Conductance
- D. SMACNA Duct Liner Application Standard

1.5 SHOP DRAWINGS

- A. Submit product data and installation instructions in accordance with Section 230500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Johns-Manville, Knauf, Owens-Corning or CertainTeed meeting these specifications are acceptable.

2.2 MATERIALS

- A. All low pressure rectangular supply and return ductwork shall be provided with Type 1 flexible duct liner, 1" thick, 1-1/2 lbs. per cubic foot density "K" value at 75 degrees F mean temperature of 0.26 BTU/in/sq. ft./degrees F/hr., suitable for temperature range of 40 degrees F to 250 degrees F and maximum velocity of 4000 fpm.
- B. Weld pins or approved equal mechanical fasteners capable of withstanding 50 lb. tensile load test.

- C. Adhesives meeting FM, UL and NFPA requirements for fire and smoke ratings, maximum 25 flame spread and maximum 50 smoke developed. Adhesives shall conform to Adhesive and Sealant Council Standards for Adhesives for Duct Liner ASC-A-7001C-1972.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All duct designated to receive liner shall be completely covered with liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The black coated surface of the duct liner shall face the air stream. Provide 26 gauge galvanized steel "Z" strip at leading edge of duct liner.
- B. Duct liner shall be adhered to sheet metal with mechanical fasteners and 100% coverage of adhesive. Transverse edges of liner to be coated with adhesive. Duct liner shall be cut to assure overlapped and compressed longitudinal corner joints.
- C. For velocities up to 2,000 feet per minute, fasteners shall start within 3" of the upstream transverse edges of the Duct Liner and 3" from the longitudinal joints and shall be spaced at a maximum of 12' o.c. around the perimeter of the duct, except that they may be a maximum of 12" from corner break. Elsewhere they shall be a maximum of 18" o.c. except that they shall be placed no more than 6" from a longitudinal joint of the liner nor 12" from a corner break.

END OF SECTION

SECTION 233115 - DUCT INSULATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Duct Thermal Insulation
- B. Adhesives, Tie Wires, Tapes

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 233113 – Ductwork

1.03 QUALITY ASSURANCE

- A. All insulation materials required for ductwork shall be furnished and installed under the contract. The execution of the work shall be by approved insulation contractor in strict accordance with the best practice of the trade and the intent of the specification.
- B. It is mandatory that all insulation be applied in a neat and workmanlike manner. Contractor shall be required to remove and replace all insulation not applied in strict accordance with the manufacturer's specifications or not presenting a neat finished appearance.
- C. The Ductwork insulation shall meet NFPA Standards 902 and 906 for fire resistance.

1.04 SUBMITTALS

- A. Submit product data and installation instructions in accordance with Section 230500.

1.05 REFERENCE STANDARDS

- A. NFPA 90A and 90B.
- B. ASTM Standard E84-75.

1.06 JOB CONDITIONS

- A. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Materials as manufactured by Certain-Teed, Johns-Manville, Knaul, Owens-Corning, Foster Products, Childers or approved equal meeting these specifications are acceptable.

2.02 TYPE AND PERFORMANCE

- A. Adhesives and Insulation Materials: Composite fire and smoke hazard ratings maximum 25 for Flame Spread and 50 for Smoke Developed. Adhesives to be waterproof.
- B. Concealed Medium Pressure Supply and All Round Supply and Return Ducts: Rigid or Flexible fibrous glass insulation, 1 1/2 inch thick "K" value at 75 degrees F maximum 0.26 btu/hr./sq.ft./Deg. F/hr. with factory applied reinforced aluminum foil vapor barrier for temperatures for +40 Deg. F to +250 Deg. F services.
- C. All medium pressure supply ductwork in mechanical rooms shall be externally insulated with minimum 2" thick rigid board insulation with canvas or aluminum jacket. Insulation shall be 3lb/cu.ft. density. Canvas jacket shall be minimum 8 ounce and applied per manufacturer's requirements. Aluminum jacket shall be minimum 0.016 inch thick aluminum jacketing with caulked joints and seams.

PART 3 EXECUTION

3.01 PREPARATION

- A. Do not install covering before ductwork has been tested and approved.
- B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.02 INSTALLATION

- A. Ensure installation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material, properly sealed.
- B. Finish insulation neatly at hangers, supports and other protrusions.
- C. Locate insulation or cover seams in least visible locations.
- D. Concealed Ducts: Adhere flexible insulation to ductwork with adhesive applied in 6 inch wide strips on 16 inch centers. Provide 16 gage annealed tie wire tied, spiral wound or half hitched at 16 inch centers for securing duct insulation until adhesive sets. Butt insulation and seal joints and breaks with 2 inch of foil adhered over joint.
- E. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

END OF SECTION

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Access Doors
- B. Balancing Dampers
- C. Backdraft Dampers
- D. Flexible Connections
- E. Turning Vanes

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230593 – Testing, Adjusting & Balancing For HVAC
- C. Section 230700 – HVAC Insulation
- D. Section 233113 – Ductwork
- E. Section 232114 – Duct Lining
- F. Section 233417 – Utility Fans
- G. Section 233423 – HVAC Power Ventilators
- H. Section 233713 – Diffusers, Registers & Grilles

1.3 QUALITY ASSURANCE

- A. Access doors shall be UL labeled.
- B. Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems as applicable.
- C. Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

1.4 SUBMITTALS

- A. Submit product data in accordance with Section 230500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Air Balance, Greenheck, DuroDyne, Penn, Krueger, Safe Air, Dowco or Ruskin meeting these specifications are acceptable.

2.2 ACCESS DOORS

- A. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For internally lined or insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- B. Provide two hinges and two sash locks for sizes up to 18 inch square, two hinges and two compression latches with outside and inside handles for sizes up to 24 inch x 48 inch. Provide an additional hinge for larger sizes.

2.3 DAMPERS

- A. Fabricate balancing dampers of galvanized steel, minimum 16 gauge and provide with locking quadrants.
- B. Fabricate splitter dampers of double thickness sheet metal, properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum size 16 sq. ft. Assemble center and edge crimped blade in prime coated or galvanized channel frame with suitable hardware and locking quadrant.
- D. Fabricate multi-blade, counter balanced backdraft dampers with blades a maximum 8 inch width having felt or flexible vinyl sealing edges, linked together in rattle-free manner and width adjustment device to permit setting for varying differential static pressure.

2.4 FLEXIBLE CONNECTION

- A. Fabricate of neoprene coated flameproof fabric approximately 4 inch wide tightly crimped into metal edging strip and attach to ducting and equipment by screws or bolts at 6 inch intervals.

2.5 TURNING VANES

- A. Fabricate turning vanes and rails of 24 gauge galvanized steel and assemble rattle free.
- B. Turning vanes shall be single thickness prefabricated or assembled per manufacturer's instructions for optimum shape.
- C. Secure to duct with sheet metal screws, rivets or weld. Final assembly shall be rattle free.

2.6 APPLICATION

- A. Provide access doors for inspection and cleaning at filters, fans, terminal units, fire/smoke dampers, and as indicated on the drawings. Review locations prior to fabrication.
- B. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing and where indicated on the drawings.
- C. Provide flexible connections immediately adjacent to equipment, in ducts associated with fans, equipment subject to forced vibration and as shown on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install items in accordance with manufacturer's printed instructions and SMACNA Standards.
- B. For connections to fans, install 1/2 inch thick neoprene pad over fabric and hold in place with additional metal strips.

END OF SECTION

SECTION 233417 - UTILITY FANS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Utility Fans

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230593 – Testing, Adjusting & Balancing For HVAC
- C. Section 230900 – Instrumentation & Control For HVAC
- D. Section 233113 – Ductwork
- E. Section 233300 – Air Duct Accessories
- F. Division 26 – Electrical Requirements

1.3 QUALITY ASSURANCE

- A. ANSI/AMCA Standard 99-10, "Standards Handbook"
- B. ANSI/AMCA Standard 204-05, "Balance Quality and Vibration Levels for Fans"
- C. ANSI/AMCA Standard 210-07, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"
- D. AMCA Publication 211-05, "Certified Ratings Program – Product Rating Manual for Fan Air Performance"
- E. ANSI/AMCA Standard 300-08, "Reverberant Room Method for Sound Testing of Fans"
- F. AMCA Publication 311-05, "Certified Ratings Program – Product Rating Manual for Fan Sound Performance"
- G. AMBA Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999)
- H. ANSI/AMCA Standard 500-D-12, "Laboratory Methods of Testing Dampers for Rating"
- I. ANSI/AMCA Standard 500-L-12, "Laboratory Methods of Testing Louvers for Rating"
- J. SMACNA - Medium Pressure Plenum Construction Standard
- K. ANSI/AIHA Z9.5-2012 – Laboratory Ventilation
- L. ASHRAE - Laboratory Design Guide

- M. OSHA guideline 1910.212 – General requirements for Machine Guarding. (www.osha.gov)
 - N. OSHA guideline 1910.219 – General requirements for guarding safe use of mechanical power transmission apparatus. (www.osha.gov)
 - O. OSHA guideline 1926.300 – General requirements for safe operation and maintenance of hand and power tools. (www.osha.gov)
 - P. UL Standard 705, “Power Ventilators”
- 1.4 SUBMITTALS
- A. Submit product data including dimensional data, material specifications, capacity data, sound data and installation procedures in accordance with Section 230500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Greenheck, Cook, Twin City, or Penn/Barry meeting these specifications are acceptable.

2.2 PERFORMANCE

- A. Provide air flow capacity and all other performance requirements scheduled on the drawings.

2.3 CONSTRUCTION

- A. All steel fan and system components (fan, housing, nozzle, windband and plenum) shall be corrosion resistant coated with epoxy rated for lab fume hoods, a two part electrostatically applied and baked, sustainable, corrosion-resistant coating system.
- B. Fan housing shall be centrifugal involute scroll, allowing all drive components including the motor to be serviced without contact of the contaminated airstream, and manufactured of welded steel. Fan shall be spark resistant construction.
- C. Fan impeller shall be centrifugal, single width single inlet, backward inclined airfoil blade design with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically exceeding AMCA Standards.
- D. A high velocity discharge nozzle shall be supplied by the fan manufacturer designed to efficiently handle an outlet velocity of up to 7000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
- E. Motors shall be premium efficiency, standard NEMA frame, 1800 or 3600 RPM, TEFC with a 1.15 service factor. A factory-mounted NEMA 3R disconnect switch shall be provided for each fan. Motor shall be permanently lubricated, heavy duty ball bearing type, of the voltage, phase and horsepower specified. Provide adjustable motor supports, variable drive sheave with companion sheave and anti-friction ball bearings.

- F. Provide variable frequency drive with manual by-pass starter equal of ABB Model ACH550 with full ASHRAE BACnet communication connection for field installation.
- G. Provide weather cover for belt and motor section.
- H. Provide factory roof curb with 2" deflection housed spring isolators. Roof curb shall match roof slope or be shimmed in the field to be level.
- I. All shaft bearings and non-permanently lubricated motors shall have extended lube lines with Zerk fittings.
- J. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized. A bolted housing access door shall be supplied for impeller inspection.
- K. Belt drive configuration shall be AMCA arrangement 10. Drive belts and sheaves shall be sized for 200% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.

2.4 BY-PASS AIR PLENUM

- A. The plenum shall be provided with bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air weatherhood and bird screen.
- B. The plenum shall be provided with bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air weatherhood and bird screen.
- C. The bypass air plenum shall be mounted on an insulated curb.
- D. Bypass air damper(s) shall be opposed-blade design for airflow control, airfoil design, fabricated of galvanized steel. Bypass damper(s) shall have plated steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper model shall be equal to or exceed a heavy duty control damper, All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.

2.5 CONTROLS

- A. Provide factory mounted controller, airflow sensor, and bypass damper modulating actuator. Provide remote exhaust duct pressure sensor or coordinate with controls in Section 230900.
- B. Provide factory mounted 120/24VAC transformer and controller enclosure with NEMA 3R or 4 weather panel mounted to exhaust fan.
- C. Provide factory controller to modulate fan VFD based on exhaust duct static pressure and modulate bypass damper to maintain constant airflow discharge velocity.
- D. Controller shall have ASHRAE BACnet communication.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install fan as per drawing and in compliance with manufacturer's instructions. Carefully coordinate exact location with existing conditions.
- B. Connect to ductwork as specified in Section 233113.
- C. Balance in accordance with Section 230593.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Single duct terminal units.

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230529 – Hangers & Supports for HVAC
- C. Section 230593 – Testing, Adjusting & Balancing For HVAC
- D. Section 230900 – Instrumentation & Control For HVAC
- E. Division 26 – Electrical Requirements

1.3 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 - Factory-Made Air Ducts and Connectors.
- C. ARI 880 - Air-Conditioning and Refrigeration Institute Standard Rating Conditions for Air Terminals

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 230500.
- B. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and radiated sound power levels (2nd through 7th octave bands) at design maximum operating conditions.
- C. Submit manufacturer's installation instructions.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data.
- C. Include directions for resetting all control setpoints.

1.6 WARRANTY

- A. Provide one year manufacturer's parts and labor warranty.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Trane, Carrier, Titus, Krueger, Nailor, or Price meeting these specifications.
- B. Unit performance data must be Rated in Accordance with ARI Standard 880, and must display the ARI Symbol on all standard units.

2.2 PERFORMANCE

- A. Unit performance shall meet or exceed performance scheduled on the drawings.

2.3 GENERAL

- A. Identify each terminal unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory set air flow and minimum factory set air flow.

2.4 FABRICATION

- A. Casings: Units shall be completely factory assembled, manufactured of corrosion protected welded steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the VAV dampers and 22-gauge metal on the low pressure (outlet) side and unit casing.
- B. Lining: Minimum 1/2 inch thick tuff-skin mat or aluminum foil-faced glass insulation, 1.5 lb/cu ft. density, meeting NFPA 90A requirements and UL 181 erosion requirements.
- C. Assembly: Air volume damper, fans and controls in single cabinet.

2.5 VOLUME DAMPER

- A. Air volume control dampers shall be factory calibrated and tested assembly consisting of air modulation dampers and extension for connection to control actuators. All actuator linkages shall be protected by a sheet metal enclosure.

2.6 CONTROLS

- A. Provide inlet air flow sensor, control cabinet, and 120/24VAC control power transformer with inlet/outlet disconnects.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 233713 – DIFFUSERS, REGISTERS & GRILLES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Supply, Return, Transfer and Exhaust Air Devices and Accessories.

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230593 – Testing, Adjusting & Balancing For HVAC
- C. Section 233113 – Ductwork
- D. Section 233300 – Air Duct Accessories

1.3 QUALITY ASSURANCE

- A. Make air flow tests and sound level measurement in accordance with applicable ADC equipment test codes and ASHRAE standards.
- B. Manufacturer shall certify cataloged performance and ensure correct application of air outlet types.

1.4 SUBMITTALS

- A. Submit in accordance with Section 230500.
- B. Submit product data and shop drawings covering each item together with schedule of outlets, listing cfm, neck velocity, NC level and Ak factor and air flow measurement procedures.

1.5 JOB CONDITIONS

- A. Review requirements (including architectural drawings) of outlets as to size, finish, and type of mounting prior to submitting shop drawings and schedules of outlets.
- B. Check location of outlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products manufactured by Krueger, Tuttle & Baily, Titus, J&J, Price or Nailor, meeting these specifications are acceptable.

2.2 GENERAL REQUIREMENTS

- A. Provide air devices equal in all respects to those scheduled on the drawings.
- B. Rate units in accordance with ADC standards.

- C. Base air outlet application on space noise level of NC 35 maximum in all areas unless indicated otherwise on drawings.
- D. Provide supply outlets with sponge rubber seal around edge.
- E. All devices shall be factory finished.
- F. When required provide air devices factory installed in metal panels painted to match air device finish. Panel shall be suitable for insertion into lay-in-tile ceilings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install items in accordance with manufacturer's printed instructions.
- B. Paint ductwork visible behind air outlets matt black.
- C. Seal square to round adaptors or lined plenum boxes air tight to diffusers or grilles.
- D. When required cut metal panels for insertion in ceiling at grid location where tiles may be less than nominal size. Center diffuser or grille within modified panel.

END OF SECTION

SECTION 237313 - AIR HANDLING UNITS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Air Handlers
- B. Electrical and Controls
- C. ETL Listed and Labeled

1.2 RELATED WORK

- A. Section 230500 – Common Work Results for HVAC
- B. Section 230519 – Mechanical Piping Specialties
- C. Section 230523 – General-Duty Valves For HVAC
- D. Section 230593 – Testing, Adjusting & Balancing For HVAC
- E. Section 230900 – Instrumentation & Control For HVAC
- F. Section 232113 – Hydronic Piping
- G. Section 233113 – Ductwork
- H. Section 233300 – Air Duct Accessories
- I. Division 26 – Electrical Requirements

1.3 QUALITY ASSURANCE

- A. Provide fans bearing AMCA certified rating seal.

1.4 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 230500.
- B. Submit coil capacity data, motor data and filter data.
- C. Submit fan curves showing fan performance with system operating point plotted on curves.
- D. Submit dimensioned data.
- E. Submit manufacturer's installation instructions and maintenance and operating procedures.

1.5 REFERENCED STANDARDS

- A. ASHRAE Test Standard 52-76.
- B. UL listing for filters, Class 2.

- C. ARI Standard 410.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Units manufactured by Carrier, Daikin, Energy Labs, Huntair, BASX Solutions, Nortek, Temtrol, Trane, York meeting these specifications are acceptable.

2.2 TYPE AND PERFORMANCE

- A. Provide draw-through design as indicated on contract drawings.
- B. Unit shall meet or exceed the performance schedule on the drawings.

2.3 CASING

- A. Provide minimum 2" thick double wall AHU casing. Exposed insulation is not acceptable. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338. Encapsulate insulation with sheet metal so that air does not contact insulation. Solid lined panels insulated with spray injected foam shall be hermetically sealed at each corner and around their entire perimeter, to eliminate airflow through the panel and to eliminate microbial growth potential within the casing wall. Provide casing with minimum thermal resistance (R-value) of 17 hr-ft²-°F/BTU. Provide panels with acoustical perforated liner in the fan section. Interior liner will be perforated galvanized. Minimum perforated panel thermal resistance (R-Value) will be R11 hr-ft²-°F/BTU.
- B. Provide a unit frame of galvanized steel that provides the overall structure of the unit and does not rely on the casing panels for structural integrity. Insulate frame in the same manner as panels, roof, and floors.
- C. Provide AHU casing that leaks no more than 1% of design airflow at +/-8" w.g.
- D. Provide wall panels and access doors that deflect no more than L/240 when subjected to +/- 8" w.g. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint. Provide floors and roofs that deflects no more than L/240 when subjected to a 300 lb load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.
- E. Provide double wall hinged access doors for access to sections and components requiring servicing. Doors shall be adequately sized and swing 180 degrees to allow operating personnel to access unit. Doors shall be of the same construction as the wall casing. Provide gasket seals, door latch and handle assemblies.

2.4 FANS

- A. Fan performance shall be AMCA certified.
- B. All fans shall be statically and dynamically balanced including final trim balance at the factory for quiet operation.
- C. Fans shall be multiple single width single inlet direct drive airfoil plenum fans. Fans shall not pass through their first critical speed before reaching operating RPM.

- D. Provide solid steel fan shafts with self-aligning ball bearings having minimum average life of 200,000 hours. Extend lubrication fittings to exterior of fan casing.
- E. Provide OSHA fan and drive guard. Provide fan inlet guard.
- F. Fan shall be isolated from unit with 1" minimum deflection spring isolators with seismic restraints.

2.5 FILTER SECTION

- A. Filters shall be provided with holding frames and all required hardware shall be serviceable from both sides of the unit.
- B. Filters shall be 2" thick MERV 8 efficiency, disposable, pleated media type. The efficiency shall be per the ASHRAE Test Standard 52-76. Filters shall be UL listed, Class 2.
- C. The media shall be a nonwoven cotton fabric and shall be reinforced with a wove scrim backing. The media support grid shall be welded wire with an approximate free area of 96 percent. The wire grid shall be bonded to the media.
- D. The enclosure frame shall be constructed of a rigid heavy- duty chipboard secured to the air entrance and exit side of each pleat.
- E. Holding frames shall be factory fabricated of 16 gauge minimum galvanized steel and shall be provided with gaskets and spring type positive sealing fasteners.
- F. An additional filter section shall be provided for future carbon filters or 12" thick MERV 13 filters.
- G. Provide flush mount differential pressure gauge across the pre-filter section.
- H. One set of filters shall be provided with the unit during construction and one set for testing and balancing of the unit.

2.6 COILS

- A. Enclose coils in coil section with headers and U-bends fully contained within the casing.
- B. Coils shall be removable from the unit without dismantling the unit. Water coil capacities, pressure drops and selection procedures shall be certified in accordance with ARI Standard 410-64. Coils shall have same end supply and return connections unless otherwise indicated. All coils shall be leak tested by the manufacturer.
- C. Coils shall be of the extended surface type meeting all conditions and having the minimum face area and pressure drops scheduled on the drawings. Coils shall be constructed of 5/8" O.D. copper tubes and plate type aluminum or copper fins bonded to the tubes by mechanical expansion. Minimum acceptable tube thickness is 0.02" and minimum acceptable fin thickness is 0.008. Coil headers shall be constructed of close gained cast iron extra heavy copper or extra heavy red brass. The coil section shall be provided with a galvanized steel casing no lighter than 16-gauge. Galvanized intermediate tube support sheets shall be provided in coils having tube lengths in excess of 48" and on long coils the spacing of coil supports shall not exceed 48".
- D. Maximum coil face velocity shall be 450 fpm. Maximum fin spacing shall be 12 fpi.
- E. Condensate drain pans shall be fabricated from 16 gauge 304 stainless steel. Drain pans shall be double sloped at minimum 1/8" per foot for complete drainage with no standing water in the unit.

2.7 MOTORS AND VARIABLE FREQUENCY DRIVE

- A. Motors shall be open-drip-proof premium efficiency type with a minimum 1.15 service factor with greasable ball bearings and of the voltage scheduled on the drawings. Motors shall be inverter ready and compatible with variable frequency drive.
- B. Factory install and wire variable frequency drive with manual by-pass starter equal of ABB Model ACH550 with full ASHRAE BACnet communication connection.
- C. Provide wiring from VFD to fan motor per NEC requirements. Provide conduit routing through unit exterior for single point field electrical connection to unit.

2.8 CONTROLS

- A. Provide factory installed and wired 24VAC transformer connected to the fan motor primary power with hi/lo disconnects. Transformer shall be adequately sized for air handler field mounted controller and all associated sensors and actuators.
- B. Provide factory installed and wired control components described in the contract documents including the control drawings, sequence of operation, and Section 230900. Provide wiring from each device to a terminal strip located in a control enclosure with sufficient space for a field mounted air handler controller. All wiring and terminals shall be clearly labeled. Devices and sensor to be factory shall meet all the requirements of Section 230900 and shall include the following:
 - 1. Variable frequency drive enable/disable, frequency input, operating frequency, alarm status, and full BACnet communication connection.
 - 2. Fan high limit differential pressure sensor factory interlocked to disable VFD if fan pressure exceeds the value described in the sequence of operation.
 - 3. Full face averaging supply air temperature sensor.
 - 4. Freeze stat set at 40F and wired to shut-down fan.
 - 5. Supply airflow monitor to measure and display supply air cfm.
 - 6. Outside airflow monitor to measure and display outside air cfm.
 - 7. Filter differential pressure gauge and sensor, photohelic gauge.
 - 8. Outside air damper with 24V N.C. modulating actuator.
- C. Factory calibrate and commission all controls.

2.9 ELECTRICAL

- A. Provide a U.L. listed and labeled (as a completed assembly) single source power and control panel including all of the necessary starters, VFDs, transformers, branch circuit protection and main fused disconnect, factory wired to the air handler's electrical devices such as fan motors, and controls.
- B. Provide LED lighting in each air handler section in vapor proof marine-type fixtures with a labeled toggle switch mounted near the filter access door. Provide all conduit and wiring for the lights and switch to the main control panel. All wiring and installation shall be per NEC requirements and be UL listed.

PART 3 EXECUTION

3.1 ASSEMBLY

- A. Assemble fan by bolting sections together to make single unit.

3.2 FACTORY TESTING

- A. Weigh fan and motor assembly at factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, isolation bases and isolators. The assembled fan section shall be run and the peak to peak displacement shall be measured at the pillow block bearing in all three dimensions per ASTM DH167 Standards. Allow spring isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions. Balance at design RPM's as scheduled on drawings and balance in accordance with ARI Guideline D or better. For fan sections controlled by variable frequency drives, balance at all speeds between 25% and 100% of design RPM.
- B. Balance variable volume fan assemblies from 10% to 100% of design RPM.
- C. Manufacturer shall hipot test wiring intended to carry voltages greater than 30VAC.

3.3 INSTALLATION

- A. Install items in accordance with manufacturer's instructions and as shown on the drawings.

3.4 START-UP

- A. Provide the services of a factory authorized service technician to assist the installing contractor with startup services and instruct the contractor and owner's personnel in the maintenance and use of the equipment.

END OF SECTION

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - . Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1. COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 0 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 0 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 3/A 3M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 0 inches (12 0 mm) and no side more than 1 inches (400 mm), thickness shall be 0.0 2 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 0 inches (12 0 mm) and 1 or more sides equal to, or more than, 1 inches (400 mm), thickness shall be 0.13 inch (3. mm).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products Systems, Inc.

- b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
- 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 110 , factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Extend sleeves to unistrut support on both surfaces of walls.
- F. Extend sleeves installed in floors 4 (inches) (0 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 0 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 0 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (2 -mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (2 -mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 0 Section "Penetration Firestopping."

END OF SECTION 2 0 00

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 00 V and less.
 - 2. Connectors, splices, and terminations rated 00 V and less.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Division 2 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910. , and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for

Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1. COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation Alcan Cable Division.
 - 2. American Insulated Wire Corp. a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, and XHHW.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney EGS Electrical Group LLC.
 - 4. 3M Electrical Products Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 3/A 3M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.02- or 0.13 -inch (1.3- or 3. -mm) thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 0 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller stranded for No. AWG and larger.

- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller stranded for No. 10 AWG and larger.
- C. Minimum circuit conductor size shall be No. 12.
- D. Vibrating and rotating equipment and controls: Copper. Stranded for No. 10 and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway or Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

- B. Use manufacturer-approved pulling compound or lubricant where necessary compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 2 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 2 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 4 A and UL 4 B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least inches (1 0 mm) of slack.

3. SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 0 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

- D. Rectangular Sleeve Minimum Metal Thickness:
1. For sleeve rectangle perimeter less than 60 inches (1524 mm) and no side greater than 16 inches (406 mm), thickness shall be 0.02 inch (0.5 mm).
 2. For sleeve rectangle perimeter equal to, or greater than, 60 inches (1524 mm) and 1 or more sides equal to, or greater than, 16 inches (406 mm), thickness shall be 0.13 inch (3.3 mm).
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Sleeves shall extend past wall and shall be supported by metal framing on both side of wall.
- G. Extend sleeves installed in floors 4 inches (102 mm) above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 0 Section "Joint Sealants."
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 0 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25.4-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25.4-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.
3. SLEEVE-SEAL INSTALLATION
- A. Install to seal underground exterior-wall penetrations.

- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3. FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 0 Section "Penetration Firestopping."

3. FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

- B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance, feeder and branch circuit conductors for compliance with requirements (Provide continuity and insulation testing on all feeder and branch circuit conductor. Insulation testing shall be performed with a 00 VDC megger. Phase and neutral conductors shall be tested free of short-circuits and grounds. For continuity testing, motor feeders shall be measured with motors connected and local disconnect closed readings shall be one phase-to-ground for each phase. Test all other conductors phase-to-phase and phase-to-ground).
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Provide testing of proper phase rotation for three-phase system. Provide individual tests at all service entrance, motor control center and other sources that feed equipment that may be adversely affected by incorrect phase rotation, especially rotating machines.

- C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
4. The contractor shall furnish the instruments, materials, and labor for all tests at no additional cost to the owner (i.e., it must be part of the bid

price). Contractor shall present to the owner three copies of certified test reports. In addition to the various electrical measurements results, the test reports shall, at minimum, include the official City of Tucson FD M project name, the project address, City of Tucson building number, City of Tucson FD M A/E Section project number, name of the test, name of the equipment tested, location in the building of the equipment tested, Project General contractor, Contractor performing the test, date, time, and temperature. The City Electrical Engineer desires that the contractor use pre-printed industry form, if available, for recording and reporting electrical test. The City Electrical Engineer expects the test results to be reported in a reasonable, easily read format and expects the use of good common English, accurate spelling and good penmanship in the reports. The City Electrical Engineer reserves the right to reject test reports that are difficult to interpret. This does not exclude using narrative to explain the test reports, methods and unusual field circumstances that may contribute to difficult testing situations.

- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 2 0 19

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Ground rods.
 - 2. Grounding arrangements and connections for separately derived systems.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the

International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910. , and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 0, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 4 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 00 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B .
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: 2 kcmil, 14 strands of No. 1 AWG conductor, 1/4 inch (mm) in diameter.
 - . Bonding Conductor: No. 4 or No. AWG, stranded conductor.
 - . Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules 1- / inches (41 mm) wide and 1/1 inch (1. mm) thick.
 - . Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules 1- / inches (41 mm) wide and 1/1 inch (1. mm) thick.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. AWG and smaller, and stranded conductors for No. AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (00 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (2 mm), minimum, from wall inches (1 0 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 0:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 - . Three-phase motor and appliance branch circuits.
 - . Flexible raceway runs.
 - . Armored and metal-clad cable runs.
 - . Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated

grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (-by- 0-by-300-mm) grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 70 and UL 98 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system, install at least 2 rods spaced at least six feet from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 0 feet (1 m) apart.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 0, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- B. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 1.
 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 00 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity 00 to 1000 kVA: ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 2 0 2

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 2 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1. SUBMITTALS

- A. Product Data: For the following:

- 1. Steel slotted support systems.
- 2. Nonmetallic slotted support systems.

- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

- 1. Trapeze hangers. Include Product Data for components.
- 2. Steel slotted channel systems. Include Product Data for components.
- 3. Nonmetallic slotted channel systems. Include Product Data for components.
- 4. Equipment supports.

- C. Welding certificates.

1. QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 0.

1. COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 0 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube Conduit.
 - b. Cooper B-Line, Inc. a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas Betts Corporation.
 - f. Unistrut Tyco International, Ltd.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - . Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 1/2 inches (200 mm) o.c., in at least 1 surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube Conduit.
 - b. Cooper B-Line, Inc. a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles.
 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 3 /A 3 M, steel plates, shapes, and bars black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc. Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc. a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head a division of Illinois Tool Works, Inc.
 -) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 1 complying with MFMA-4 or MSS SP- .
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP- , type suitable for attached structural element.
 - . Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 32 .

- . Toggle Bolts: All-steel springhead type.
- . Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 0 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 0. Minimum rod size shall be 1/4 inch (6.35 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 2 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38.1 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 0.

- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 - . Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - . To Steel: Beam clamps MSS Type 19, 21, 23, 2 , or 2 , complying with MSS SP- 9.
 - . To Light Steel: Sheet metal screws.
 - . Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Support ceiling outlets boxes from ceiling structure. Support boxes in suspended ceiling systems from main runner channels, or joist, or other structural members. For boxes in suspended ceilings, supplement outlet box support with separate support to the structure as required for the expected load of the device, such a ceiling fan.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 0 Section "Metal Fabrications" for site-fabricated metal supports.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20. -MPa), 2 -day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3. PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.0 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 0.

END OF SECTION 2 0 29

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 2 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:

- a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Structural members in the paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Qualification Data: For professional engineer and testing agency.
- E. Source quality-control test reports.
1. QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AFC Cable Systems, Inc.
 2. Alflec Inc.
 3. Allied Tube & Conduit a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc. Anaconda Metal Hose.
 - . Electri-Flex Co.
 - . O-Z Gedney a unit of General Signal.
- B. Rigid Steel Conduit: ANSI C 300.1.
- C. IMC: ANSI C 300.2.

- D. EMT: ANSI C 0.3.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1 listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL .
 - 2. Fittings for EMT: compression type, steel. Set screw fittings are not allowed.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. CANTEX Inc.
 - 3. Electri-Flex Co.
 - 4. Lamson Sessions Carlon Electrical Products.
 - . Manhattan/CDT/Cole-Flex.
 - . RACO a Hubbell Company.
 - . Thomas Betts Corporation.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- D. LFNC: UL 1 0.
- E. Fittings for ENT and RNC: NEMA TC 3 match to conduit or tubing type and material.
- F. Fittings for LFNC: UL 14B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arnco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson Sessions Carlon Electrical Products.
- B. Description: Comply with UL 2024 flexible type, approved for general-use installation.

2.4 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 2 0, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type.
- E. Finish: Manufacturer's standard enamel finish.

2. SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas Betts Corporation.
 - b. Walker Systems, Inc. Wiremold Company (The).
 - c. Wiremold Company (The) Electrical Sales Division.

2. The surface raceways shall be supplied as a complete system using accessories and fittings of the same manufacturer.

2. BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
 - . Hubbell Incorporated Killark Electric Manufacturing Co. Division.
 - . O-Z/Gedney a unit of General Signal.
 - . RACO a Hubbell Company.
 - . Robroy Industries, Inc. Enclosure Division.
9. Thomas Betts Corporation.
10. Walker Systems, Inc. Wiremold Company (The).

- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover. Boxes in wall shall be 4 X 4 metal box with single mud ring. Exterior and surface boxes shall be waterproof deep bell.

- D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular..

- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized with gasketed cover.

- G. Hinged-Cover Enclosures: NEMA 2 0, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Cabinets and enclosures shall have blank ends and sides, no knockouts. The contractor shall punch out openings required. All unused openings shall be plugged with manufactured plugs.
3. Do not use single covers for junctions and pull boxes having cover length or width dimension exceeding three feet unless so approved. Sectionalize covers exceeding three feet in either dimension into two or more sections.

H. Cabinets:

1. NEMA 2 0, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
 - . Accessory feet where required for freestanding equipment.
 - . Cabinets and enclosures shall have blank ends and sides, no knockouts. The contractor shall punch out openings required. All unused openings shall be plugged with manufactured plugs.
 - . All cabinets and enclosures shall have a protective pocket inside the front cover with schematic diagram, connection diagram, and/or as applicable layout drawing of wiring and components within enclosures or boxes that contain electrical equipment, terminal strips and the like.
 - . All cabinets and enclosures that contain equipment like relays, terminal boards or terminal trips shall have hinged covers.

2. SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 3/A 3M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.02- or 0.13 -inch (1.3- or 3. -mm) thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 0 Section "Penetration Firestopping."

2. SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.

- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit.
 2. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 4. Boxes and Enclosures, Aboveground: NEMA 2 0, Type 3R.
 - . Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE , Tier 1 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE , Tier structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE with 3000-lbf (13 34 -N) vertical loading.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: Rigid steel conduit.
 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.

- b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - . Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - . Damp or Wet Locations: Rigid steel conduit.
 - . Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air.
 - . Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: IMC.
 - 9. Boxes and Enclosures: NEMA 2 0, Type 1, except use NEMA 2 0, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 1-inch (25.4-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
- 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 1/2 inches (12.5 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 2 Section "Hangers and Supports for Electrical Systems."

- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit or max 20 degrees deflection.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (25-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from ENT to RGS conduit before rising above the floor.
- I. All underground conduit elbows (sweeps) shall be rigid steel, wrapped with two layers of 10 mil. PVC tape applied for corrosion protection. Do not allow PVC or PVC coated steel elbows.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 - 1. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 30 feet (9.1 m).
 - 2. Install with a maximum of three 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 0.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (1 deg C), and that has straight-run length that exceeds 2 feet (. m).
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 12 deg F (0 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 1 deg F (deg C) temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 12 deg F (0 deg C) temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.0 mm per meter of length of straight run per deg C) of temperature change.
 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- O. Flexible Conduit Connections: Use maximum of 2 inches (1 30 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- Q. Set metal floor boxes level and flush with finished floor surface.
- R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- S. All panelboards shall have a minimum of (1) 3/4 spare conduit for each equivalent 3-pole spare or space stubbed out to a readily accessible location.

Each 200 Amp panelboard shall have at least one 1 spare conduit stubbed out to a readily accessible location.

- T. Install hubs and box connectors at conduit-to-enclosure connections.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 10 inches (254 mm) in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
 - . Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (76 mm) of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 10 inches (254 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 - . Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.
 - . All underground conduit elbows (sweeps) shall be rigid steel, wrapped with two layers of 10 mil. PVC tape applied for corrosion protection. Do not allow PVC or PVC coated steel elbows.
 - . All underground conduit shall be installed with a warning tape 12 inches below grade. The warning tape shall be of four mil plastic formulated for prolonged use underground, and resistant to destructive agents found in

soil. The tape shall have a continuous message in permanent ink formulated for prolonged underground use and bear the words, CAUTION ELECTRIC LINE BURIED BELOW in black letters on red background.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12. -mm) sieve to No. 4 (4. -mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (2 mm) above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3. SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 0 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 0 inches (12 0 mm) and no side greater than 1 inches (400 mm), thickness shall be 0.0 2 inch (1.3 mm).
 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 0 inches (12 0 mm) and 1 or more sides equal to, or greater than, 1 inches (400 mm), thickness shall be 0.13 inch (3. mm).
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Sleeves shall extend past wall and shall be supported by Unistrut on both sides of wall.
- G. Extend sleeves installed in floors 4" (inches) (0 mm) above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch (.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 0 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 0 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (2 -mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (2 -mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3. SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3. FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 0 Section "Penetration Firestopping."

3. PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 2 0 33

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - . Instruction signs.
 - . Equipment identification labels.
 - . Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 0.
- C. Comply with 29 CFR 1910.14 .

1. COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.14 . Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (0 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant 2 inches (0 mm) wide compounded for outdoor use.

2.2 CONDUCTOR AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.0 mm) thick by 1 to 2 inches (2 to 0 mm) wide.

- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.3 -mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.0 inch (0 by 0 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag, 0.01 inch (0.3 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 WARNING LABELS AND SIGNS

- A. Comply with NFPA 0 and 29 CFR 1910.14 .
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (.4-mm) grommets in corners for mounting. Nominal size, by 10 inches (1 0 by 2 0 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.039 -inch (1-mm) galvanized-steel backing and with colors, legend, and size required for application. 1/4-inch (.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (2 0 by 3 0 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 INCHES (91 MM)."

2.4 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2. EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Micarta Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/16 inch (10 mm).

2. MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type / nylon cable ties.
 - 1. Minimum Width: 3/16 inch (1.6 mm).
 - 2. Tensile Strength: 50 lb (22.7 kg), minimum.
 - 3. Temperature Range: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
 - 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
 - 1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior concrete and masonry primer.
 - 2) Finish Coats: Exterior semigloss acrylic enamel.
 - 2. Exterior Concrete Unit Masonry:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

- 1) Block Filler: Concrete unit masonry block filler.
- 2) Finish Coats: Exterior semigloss acrylic enamel.

- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Accessible Raceways and Metal-Clad Cables, 00 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange snap-around label.
- B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands:
1. Fire Alarm System: Red.
 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 3. Combined Fire Alarm and Security System: Red and blue.
 4. Security System: Blue and yellow.
 - . Mechanical and Electrical Supervisory System: Green and blue.
 - . Telecommunication System: Green and yellow.
 - . Control Wiring: Green and red.
- C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.14 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 2. Equipment Requiring Workspace Clearance According to NFPA 0: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- H. Instruction Signs:
1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/4-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-

(13-mm-) high letters on 1-1/2-inch- (3 -mm-) high label where 2 lines of text are required, use labels 2 inches (0 mm) high.

- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. No dymo label equipment ID allowed.

2. Equipment to Be Labeled:

- a. Panelboards, electrical cabinets, and enclosures.
- b. Access doors and panels for concealed electrical items.
- c. Electrical switchgear and switchboards.
- d. Transformers.
- e. Emergency system boxes and enclosures.
- f. Disconnect switches.
- g. Motor starters.
- h. Push-button stations.
- i. Power transfer equipment.
- j. Contactors.
- k. Remote-controlled switches, dimmer modules, and control devices.
- l. Power-generating units.
- m. Intercommunication and call system master and staff stations.
- n. Television/audio components, racks, and controls.
- o. Fire-alarm control panel and annunciators.
- p. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
- q. Monitoring and control equipment.
- r. Uninterruptible power supply equipment.
- s. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

- E. Attach nonadhesive signs and plastic labels with non reversible attachment appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 0-foot (1 -m) maximum intervals in straight runs, and at 2 -foot (. -m) maximum intervals in congested areas.
- G. Color-Coding for Phase and Voltage Level Identification, 00 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Colors for 20 /120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 2. Colors for 4 0/2 -V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of inches (1 0 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 - 4. Install a green Equipment Grounding Conductor in each conduit.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Underground-Line Warning Tape: Detectable Warning Tape. An electronically detectable Fiber Warning tape shall be installed 1 above the conduit. Tape shall be acid and alkali-resistant polyethylene film, inches wide with a minimum thickness of 0.004 inch. The tape shall have a minimum strength of 00 PSI lengthwise and 1, 00 PSI crosswise. The tape shall be manufactured with integral wires, foil backing, or other means to enable its detection by a metal detector when the tape is buried up to a depth of 3 feet deep. The tape shall be orange in color and have the following continuous inscription, CAUTION - FIBER OPTIC CABLE BURIED BELOW . The inscription shall be 2-inch black letters.

- J. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.
- K. Install wire markers on conductors at the panelboard and at each load connection. Identify with panelboard or other source name and branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams. For receptacle and lighting circuits, install the marker at each outlet.
- L. Control and alarm wiring shall be identified using wire markers. Each wire shall be uniquely identified within the control system of which it is part and uniquely identified from other control alarm system in the facility. Markers shall be self-adhering, wrapped around the conductor twice and sleeved with clear shrink sleeves installed over the marker.
- M. All junction boxes containing conductors of one circuit only shall be neatly labeled with indelible black ink, indicating panelboard, bus way, enclosure, switchboard, or other source terminal point, including circuit number as applicable. For junction boxes containing multiple circuits, require conductors be tagged as in K above.
- N. All motors shall be identified with a permanently attached durable tag with motor designation and function.
- O. All junction boxes for the fire alarm system shall be painted red. Each junction box for any other special system shall be marked as a part of the system inherently.

END OF SECTION 2 0 3

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor photoelectric switches.
 - 3. Indoor occupancy sensors.
- B. Related Sections include the following:
 - 1. Division 2 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 0, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Intermatic, Inc.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting Acuity Lighting Group, Inc.
 4. Paragon Electric Co. Invensys Climate Controls.
 - . Square D Schneider Electric.
 - . TORK.
 - . Watt Stopper (The).
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display complying with UL 91 .
1. Contact Configuration: SPST.
 2. Contact Rating: 30-A inductive or resistive, 240-V ac.
 3. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
 4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
 - . Astronomic Time: All Selected channels.
 - . Battery Backup: For schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Intermatic, Inc.
 2. Lithonia Lighting Acuity Lighting Group, Inc.
 3. Novitas, Inc.
 4. Paragon Electric Co. Invensys Climate Controls.
 - . Square D Schneider Electric.
 - . TORK
 - . Watt Stopper (The).
- B. Description: Solid state, with SPST dry contacts rated for 1 00-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input complying with UL 3A.
1. Light-Level Monitoring Range: 1. to 10 fc (1 .14 to 10 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 2. Time Delay: 1 -second minimum, to prevent false operation.
 3. Surge Protection: Metal-oxide varistor, complying with IEEE C 2.41.1, IEEE C 2.41.2, and IEEE 2.4 for Category A1 locations.
 4. Mounting: Twist lock complying with IEEE C13 .10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 INDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. Intermatic, Inc.
 3. Lithonia Lighting Acuity Lighting Group, Inc.
 4. Novitas, Inc.
 - . Paragon Electric Co. Invensys Climate Controls.
 - . Square D Schneider Electric.
 - . TORK.
 - . Watt Stopper (The).
- B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 3A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 2 -V ac, for 13-A tungsten at 120-V ac. Power supply to sensor shall be 24-V dc, 10-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: 10 to 200 fc (10 to 21.2 lx), with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 15 to 300 seconds to prevent cycling, with deadband adjustment.
 - . Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.4 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hubbell Lighting.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting Acuity Lighting Group, Inc.
 4. Novitas, Inc.
 - . Sensor Switch, Inc.
 - . TORK.
 - . Watt Stopper (The).
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 3A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 2 -V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 10-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

- . Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 - . Bypass Switch: Override the on function in case of sensor failure.
 - . Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21. to 21 2 lx) keep lighting off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounting detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of -inch- (1 0-mm-) minimum movement of any portion of a human body that presents a target of not less than 3 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (30 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (30 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 9 - inch- (2440-mm-) high ceiling.

2. LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP a division of Emerson Electric Co.
 3. Eaton Electrical Inc. Cutler-Hammer Products.
 4. GE Industrial Systems Total Lighting Control.
 - . Hubbell Lighting.
 - . Lithonia Lighting Acuity Lighting Group, Inc.
 - . Square D Schneider Electric.
 - . TORK.
 9. Watt Stopper (The).
- B. Description: Electrically operated and electrically held, combination type with fusible switch, complying with NEMA ICS 2 and UL 0 .
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 1 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 2 0.

2. CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 2 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 1 AWG. Comply with requirements in Division 2 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 2 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 2 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes terminal cabinets and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 2 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3. FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

3. ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3. DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 2 Section "Network Lighting Controls."

END OF SECTION 2 0923

SECTION 262 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. RMS: Root mean square.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 2 0, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. UL listing for series rating of installed devices.

- e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - C. Qualification Data: For testing agency.
 - D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - E. Panelboard Schedules: For installation in panelboards.
 - F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
1. QUALITY ASSURANCE
- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
 - B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
 - C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 0, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - D. Comply with NEMA PB 1.
 - E. Comply with NFPA 0.
1. PROJECT CONDITIONS
- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 122 deg F
2. Altitude: Not exceeding 00 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 00 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1. COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Measure each phase current at each panel with the panel at expected maximum demand. Require balancing of the phase currents at each panel to within +/- of the calculated average bus current, or as close as possible. Provide written record of the balanced bus current values.

1. EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Locks for panelboards shall be keyed alike.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation Cutler-Hammer Products.
 - b. General Electric Co. Electrical Distribution Protection Div.
 - c. Siemens Energy Automation, Inc.
 - d. Square D.

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 2 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 2 0, Type 3R.
 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions for flush-mounted fronts, overlap box.
 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - . Gutter Extension and Barrier: Same gage and finish as panelboard enclosure integral with enclosure body. Arrange to isolate individual panel sections.
 - . Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
 - . Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 - . Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
 9. Panelboards shall be door-in-door construction.

C. Phase and Ground Buses:

1. Provide fully rated copper bussed panelboards. Series rated and/or aluminum bussed panelboards are not acceptable.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors bonded to box.

D. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Compression type.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock keyed alike.
- B. Main Overcurrent Protective Devices: Refer to Constructions Documents.
- C. Branch Overcurrent Protective Devices:
 1. For Circuit-Breaker Frame Sizes 12 A and Smaller: Plug-in circuit breakers.
 2. For Circuit-Breaker Frame Sizes Larger Than 12 A: Bolt-on circuit breakers plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
 3. Fused switches.

2. LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-in circuit breakers, replaceable without disturbing adjacent units.

- B. Doors: Concealed hinges secured with flush latch with tumbler lock keyed alike.

2. OVERCURRENT PROTECTIVE DEVICES

- A. Circuit breaker shall be of the same manufacturer.
- B. Molded-Case Circuit Breaker: UL 4 9, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 2 0 A and larger.
 - 2. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
- C. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - 2. Application Listing: Appropriate for application Type SWD for switching fluorescent lighting loads Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.
- D. Fused Switch: NEMA KS 1, Type HD clips to accommodate specified fuses lockable handle.
- E. Fuses are specified in Division 2 Section "Fuses."
- F. Install bolt-in circuit breakers. Plug-in circuit breakers are not acceptable.
- G. Provide two and three pole breakers with common trip, and shall not require more space than the equivalent number of single-pole breakers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 2 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim 4 inches (100 mm) above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch (25.4 mm) GRC empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (25.4 mm) GRC empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components provide warning signs as specified in Division 2 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 2 Section "Grounding and Bonding for Electrical Systems."

- B. Connect wiring according to Division 2 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section . for switches and Section . for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance otherwise, replace with new units and retest.
- C. Load Balancing: After Substantial Completion, but not more than 0 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3. CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 2 241

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Snap switches and wall-box dimmers.
 - 3. Wall-switch
- B. Related Sections include the following:
 - 1. Division 2 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1. QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 0, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 0.
- D. All wiring devices shall be specification grade.
- E. Provide 12 Volts 20 Amp receptacles on 20 Amp branch circuit, 1 Amp receptacles are not allow.

1. COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

1. EXTRA MATERIALS

- A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.

2. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 1. Cooper Wiring Devices a division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass Seymour/Legrand Wiring Devices Accessories (Pass Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 12 V, 20 A: Comply with NEMA WD 1, NEMA WD configuration -20R, and UL 49 .
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper 3 2 (duplex).
 - b. Hubbell, CR 3 2 (duplex).
 - c. Leviton 3 2 (duplex).
 - d. Pass Seymour, 3 2 (duplex)..

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD , UL 49 , and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 12 V, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell
 - b. Cooper GF20
 - c. Leviton
 - d. Pass Seymour 20 4.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/240 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass Seymour 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2. WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.03 -inch- (1-mm-) thick, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 2 0, complying with type 3R weather-resistant, die-cast aluminum with lockable cover

2. FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: **Ivory**, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: **Red**.
 - 3. TVSS Devices: **Blue**.
 - 4. Wiring device cover plate shall be satin finish stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 0, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than inches (1 2 mm) in length.
 - . When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - . Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - . When conductors larger than No. 12 AWG are installed on 1 - or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - . Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install in the vertical position with the ground up.
2. Install in the horizontal position with the neutral up.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Wiring device cover plate shall be satin finish stainless steel.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

J. Wall switches (toggle switches, light switches) shall be grounding type. For single throw switches install with ON in the up position.

3.2 IDENTIFICATION

A. Comply with Division 2 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 143 .

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 10 to 132 V.
2. Percent Voltage Drop under 1 -A Load: A value of percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 143 and UL 943.
 - . Using the test plug, verify that the device and its outlet box are securely mounted.
 - . The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 2 2 2

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 00 V and less for use in switches and controllers.
 - 2. Spare-fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.
 - 4. Fuse size for elevator feeders and elevator disconnect switches.
- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

- a. Let-through current curves for fuses with current-limiting characteristics.
- b. Time-current curves, coordination charts and tables, and related data.
- c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.
- E. All fuses shall be of the same manufacturer.
- F. All power fuses shall be equipped with a blown-fuse indicator that provides visible evidence of fuse operation while installed in the fuse mounting.

1. PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (4 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1. COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1. EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Quantity equal to 10 () percent of each fuse type and size, but no fewer than 10 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eagle Electric Mfg. Co., Inc. Cooper Industries, Inc.
 2. Ferraz Shawmut, Inc.
 3. Tracor, Inc. Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse class and current rating indicated voltage rating consistent with circuit voltage.

2.3 SPARE-FUSE CABINET

- A. Cabinet: Wall-mounted, 0.0 -inch- (1.2 -mm-) thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
1. Size: Adequate for storage of spare fuses specified with 1 percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- (3 -mm-) high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Service Entrance: Class L, time delay.
- B. Feeders: Class L, time delay.
- C. Motor Branch Circuits: Class RK , time delay.
- D. Other Branch Circuits: Class RK , time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 2 2 13

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Bolted-pressure contact switches.
 - 4. High-pressure, butt-type contact switches.
 - . Molded-case circuit breakers.
 - . Molded-case switches.
 - . Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 2 0, Type 1.
 2. Current and voltage ratings.
 3. Short-circuit current rating.
 4. UL listing for series rating of installed devices.
 - . Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 2 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:
1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For testing agency.
- E. Field quality-control test reports including the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1. QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910. , and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 0, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 0.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1. PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 122 deg F
 2. Altitude: Not exceeding 00 feet (2010 m).

1. COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1. EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Spares: For the following:
 - a. Potential Transformer Fuses: **Insert number.**
 - b. Control-Power Fuses: **Insert number.**
 - c. Fuses and Fusible Devices for Fused Circuit Breakers: **Insert number.**
 - d. Fuses for Fusible Switches: **Insert number.**
 - e. Fuses for Fused Power Circuit Devices: **Insert number.**
 2. Spare Indicating Lights: **Si Insert number** of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Available Manufacturers:
1. Eaton Corporation Cutler-Hammer Products.
 2. General Electric Co. Electrical Distribution Control Division.
 3. Siemens Energy Automation, Inc.
 4. Square D/Group Schneider.
- B. Fusible Switch, 00A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- C. Nonfusible Switch, 00 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted insulated, capable of being grounded, and bonded and labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Available Manufacturers:
 - 1. Eaton Corporation Cutler-Hammer Products.
 - 2. General Electric Co. Electrical Distribution Control Division.
 - 3. Moeller Electric Corporation.
 - 4. Siemens Energy Automation, Inc.
 - . Square D/Group Schneider.
- B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 2 0 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip-Unit Circuit Breakers: RMS sensing field-replaceable rating plug with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK- .

- . Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- . GFCI Circuit Breakers: Single- and two-pole configurations with **5 30** - mA trip sensitivity.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads
Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - . Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at percent of rated voltage.
 - . Undervoltage Trip: Set to operate at 3 to percent of rated voltage with field-adjustable 0.1- to 0. -second time delay.
 - . Auxiliary Switch: Two SPDT switches with "a" and "b" contacts "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - . Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation key shall be removable only when circuit breaker is in off position.
9. Zone-Selective Interlocking: Integral with electronic trip unit for interlocking ground-fault protection function.

D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

E. Molded-Case Switch Accessories:

1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at percent of rated voltage. Provide "dummy" trip unit where required for proper operation.
4. Undervoltage Trip: Set to operate at 3 to percent of rated voltage with field-adjustable 0.1- to 0. -second time delay. Provide "dummy" trip unit where required for proper operation.

- . Auxiliary Switch: Two SPDT switches with "a" and "b" contacts "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- . Key Interlock Kit: Externally mounted to prohibit operation key shall be removable only when switch is in off position.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 2 0, Type 3R.
 - 2. Kitchen Areas: NEMA 2 0, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 2 0, Type 4.
 - 4. Hazardous Areas Indicated on Drawings: NEMA 2 0, Type C.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 2 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 2 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components provide warning signs as specified in Division 2 Section "Identification for Electrical Systems."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 2 Section "Identification for Electrical Systems."

3. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect , **test, and adjust** field-assembled components and equipment installation, including connections , **and to assist in field testing** . Report results in writing.
- B. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- E. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 2 Section "Vibration and Seismic Controls for Electrical Systems."
 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section . for switches and Section . for molded-case circuit breakers. Certify compliance with test parameters.
 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance otherwise, replace with new units and retest.
 4. Infrared Scanning:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 0 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
 - c. Instruments, Equipment and Reports:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. ADJUSTING
- A. Set field-adjustable switches and circuit-breaker trip ranges.
3. CLEANING
- A. On completion of installation, vacuum dirt and debris from interiors do not use compressed air to assist in cleaning.
 - B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 2 2 1

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes ac, enclosed controllers rated 00 V and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.
 - 2. Reduced-voltage controllers.
- B. Related Sections include the following:
 - 1. Division 2 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

- E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1. DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers install electric heating of sufficient wattage to prevent condensation.

1. PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with interruption of electrical service without Owner's written permission.

1. COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
 - C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 0 Section "Roof Accessories."
 - D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
 - E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.
1. EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
 - 2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Power Distribution, Inc. ABB Control, Inc. Subsidiary.
 - 2. Eaton Corporation Cutler-Hammer Products.
 - 3. General Electrical Company GE Industrial Systems.
 - 4. Rockwell Automation Allen-Bradley Co. Industrial Control Group.
 - . Siemens/Furnas Controls.
 - . Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
 - 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays

shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
 - 1. Control Circuit: 120 V obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
 - 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
 - 3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 - 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 94 -4-1, as certified by an NRTL.
 - 2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
 - 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 2 0, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 2 0, Type 3R.
 - 2. Other Wet or Damp Indoor Locations: NEMA 2 0, Type 4.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.

2. FACTORY FINISHES

- A. Finish: Manufacturer's standard Gray paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor required control sequence duty cycle of motor, controller, and load and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 2 Section "Hangers and Supports for Electrical Systems."

- B. Install freestanding equipment on concrete bases.
- C. Comply with mounting and anchoring requirements specified in Division 2 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 2 Section "Fuses."

3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 2 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3. IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Division 2 Section "Identification for Electrical Systems."

3. CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 2 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3. CONNECTIONS

- A. Conduit installation requirements are specified in other Division 2 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 2 Section "Grounding and Bonding for Electrical Systems."

3. FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION 2 2913

265100 INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, Conditions of the Contract, including Supplemental General Conditions and Exhibits, and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Lighting fixture supports.
- B. Related Sections include the following:
 - 1. Division 2 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.

1.3 REFERENCE STANDARDS

- 1.1.1 National Energy Policy Act of 2005, Public Law No. 109-58
- 1.1.2 IESNA LM-79-03 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information 2002.
- 1.1.3 NFPA 70 - National Electrical Code National Fire Protection Association 2005
- 1.1.4 IESNA LM-79-09 IESNA - Approved Method for Electrical and Photometric Measurements of Solid-State Lighting Products 2009
- 1.1.5 IESNA LM-80-08 IESNA - Approved Method for Measuring Lumen Maintenance of LED Light Sources
- 1.1.6 IESNA TM-21-2011 Projecting Long Term Lumen Maintenance of LED Light Sources
- 1.1.7 UL 875 - Light Emitting Diode (LED) Equipment for Use in Lighting Products

- 1.1. OSHA 29CFR1910. luminaires shall be listed by national recognized testing laboratory approved by United States Department of Labor, Occupational Safety and Health Administration (OSHA)

1.4 DEFINITIONS

CALiPER	DOE Commercially Available LED Product Evaluation and Reporting program for the testing and monitoring of commercially available LED Luminaires and lights. http://www1.eere.energy.gov/buildings/ssl/m/caliper.html
CCT	Correlated Color Temperature: The temperature in units of kelvin of a blackbody whose chromaticity most nearly resembles that of the light source in question.
cd	Candela: SI Unit of luminous intensity, equal to 1 lumen per steradian (lm/sr)
Chromaticity	The property of color of light defined by the dominant or complementary wavelength and purity aspects of the color taken together
CRI	Color Rendering Index measure of the degree of color shift of reference objects when illuminated by the light source as compared to a reference source of comparable color temperature.
fc	Footcandle: Unit of illuminance, equal to 1 lm/ft ²
L 0	The extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
LED	Light Emitting Diode
METS	Material Engineering and Testing Services of the Translab
MacAdam	Shape on the CIE chromaticity diagram that illustrates how much one can stray from the target before perceiving a difference from the target color
NEMA	National Electrical Manufacturers Association
NRTL	Nationally Recognized Testing Laboratory
NVLAP	National Voluntary Laboratory Accreditation Program - A program under the US DOE to accredit independent testing laboratories to qualify
PF	Power Factor - The ratio of the real power component to the total (complex) power component.
Rated power	Power consumption that the luminaire was designed and tested for at ambient temperature (0 F or 21 C)
RoHS	Compliance aims to restrict certain dangerous substances commonly used in electronic equipment, including Lead, Cadmium, Mercury and others.

SPD	Surge Protection Device - A subsystem or component(s) that can protect the unit against short duration voltage and current surges
SSL	Solid State Lighting
THD	Total Harmonic Distortion - The amount of higher frequency power on the power line.

1. SUBMITTALS

1. .1 See Section 013000 Administrative Requirements, for submittal procedures
1. .2 Shop drawings: Clearly indicate luminaire type, name of the job, and Architect. Contractor shall endeavor to submit all luminaire, driver and integral controls shop drawings at one time, in one package. Any re-submittals shall include all luminaire, driver and integral controls previously rejected or requiring further information. Specialty SSL, custom, or modified fixtures may be submitted as a separate package.
1. .3 Shop Drawings: Reproductions of the contract drawings are not acceptable as shop drawing.
1. .4 Product Data: Provide dimensions, ratings and specific catalog number and identification of items and accessories and performance data.
1. . Shop Drawings: Indicate any dimensions and components for each luminaire that are not a standard product of the manufacturer.
1. . Wiring Diagrams as needed for special operation or interaction with other system(s)
1. . Photometric Data: Where indicated below or for substitutions, supply complete photometric data for the fixture, including optical performance, rendered by NVLAP approved laboratory developed according to the methods of the Illuminating Engineering Society of North America. Submit electronically, in IESNA LM- 3 standard format. Types XX, YY .
1. . Submit photometric data for all substitute luminaries. Photometric reports are not required from specified manufacturer unless noted in 1. . above.
1. .9 Specification Sheets: If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer's complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L 0 life rating, and any modifications necessary to meet the requirements of the contract documents.
1. .10 Substitutions shall include complete photometric data as outlined in paragraph 1. . above, and point by point calculations for the specific conditions on the project. Samples shall be required for consideration of any

substitutions and must be submitted in accordance with the terms outlined in paragraph 1. .10 below.

1. .11 Working Samples of all substitutions: Samples shall be 120 volt with cord and plug attached, and shall include specified LEDs and all modifications necessary to meet the requirements specified in the Contract Documents.

1. QUALITY ASSURANCE

1. .1 Product shall be manufactured to conform to requirements of NEC.
1. .2 Manufacturer Qualifications: Company specializing in manufacturing recessed lighting products with minimum ten years documented experience.
1. .3 Luminaire shall be listed for damp locations by an OSHA NRTL.
1. .4 Luminaire shall have locality-appropriate governing mark and/or certification.

1. WARRANTY

1. .1 The manufacturer shall provide a warranty against loss of performance and defects in materials and workmanship for the Luminaires for a period of years from the date of shipment. Warranty shall cover all components comprising the luminaire. All warranty documentation shall be provided to customer prior to the first shipment

2 PRODUCT REQUIREMENTS

2.1 MANUFACTURERS

- 2.1.1 Approved Manufacturers: Provide products of firms regularly engaged in the manufacture of lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than years. The manufacturer of the lighting fixtures shall comply with the provisions of the appropriate code and standards. All fixtures shall be pre-tested before shipping.
- 2.1.2 Conformance: Fixtures shall be manufactured in strict accordance with the Contract Drawings and Specifications.
- 2.1.3 Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State, and local codes and regulations.
- 2.1.4 UL or CSA US Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Standards for

Safety" to UL 0 or others as they may be applicable. A listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

- 2.1. Luminaire shall be DLC Certified (Design Lights Consortium). Low lumen versions of luminaires may not meet DLC, if so delete line.
- 2.1. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.
- 2.1. Base Bid Manufacturers: Are listed on fixture schedule and specification. Manufacturers listed without accompanying catalog numbers are responsible for meeting the quality standards and photometric distribution set by the specified product.
- 2.1. Alternate Manufacturers: Identification by means of manufacturers names and catalog numbers is to establish basic features, quality and performance standards. Any substitutions must meet or exceed these standards.
- 2.1.9 Luminaire shall carry the lighting facts label verified based on LM- 9 test reports. www.lightingfacts.com

2.2 LUMINAIRES

- 2.2.1 Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.
- 2.2.2 Nominal luminaire dimensions:
 - a) 1x4 Length 4 (121.9 cm), Width 12 (30. cm) max 4 1/2 (11.43 cm) depth
 - b) 2x2 Length 24 (1.0 cm), Width 24 (1.0 cm) max. 4 (10.1 cm) (depth
 - c) 2x4 Length 4 (121.9 cm), Width 24 (1.0 cm) max. 4 (10.1 cm) depth
- 2.2.3 Integral Grid Clips required on recessed mounted luminaires along with integral tie wire mounting points.
- 2.2.4 Luminaire to have air removal capability as specified.
- 2.2. Each luminaire shall be designed for a minimum operational life of 0,000. Each luminaire shall be designed to operate at an average operating temperature of 2 C.
- 2.2. The operating temperature range shall be 0 C to 2 C.

- 2.2. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average operating temperature.
- 2.2. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
- 2.2.9 LED Boards shall be suitable for field maintenance or service with quick disconnect plugs. LED boards and drivers shall be upgradable.

2.3 TECHNICAL REQUIREMENTS

2.3.1 ELECTRICAL

- a) Power Consumption: Maximum power consumption, /- when operating between 120 2 V (or 34 V) shall be as follows:
 - a. 1x4 3 W (94 Lumens per Watt)
 - b. 2x4 0W (100 Lumens per Watt)
- b) Operation Voltage - The luminaire shall operate from a 0 or 0 HZ 3 HZ AC line over a voltage ranging from 120 VAC to 2 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. The standard operating voltages are 120 VAC, 2 VAC, 34 VAC.
- c) Power Factor: The luminaire shall have a power factor of 90 or greater at all standard operating voltages and full luminaire output.
- d) THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage.
- e) Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.
- f) The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C 4.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.
- g) Surge protection performance shall be tested per the procedures in ANSI/IEEE C 2.4 based on ANSI/IEEE C 2.41 1991 definitions for standard and optional waveforms for Location Category A-Low
- h) Driver: AccuDrive, 120 2 volt, UL Listed, CSA Certified, Sound Rated A . Driver shall be _ 0 efficient at full load across all input voltages. Input wires shall be 1 AWG solid copper minimum.
- i) Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 to of rated lumen output with a smooth shut off function. Dimming shall be controlled by a 0-10V signal.

- j) All electrical components shall be RoHS compliant
- k) Driver shall be UL listed.
- l) Maximum stand-by power shall be 1 Watt.
- m) Driver disconnect provided where required to comply with codes.
- n) The electronics/power supply enclosure shall be internal to the SSL luminaire and be accessible per UL requirements
- o) RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 4 , Subpart B, Section 1 Non-Consumer requirements for EMI/RFI emissions.
- p) Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be able to be replaced without removing the fixture from the ceiling.
- q) Emergency Battery Pack shall be factory installed and provide 1400 lm of light output for 90minutes.

2.3.2 PHOTOMETRIC REQUIREMENTS

- a) Light Output
 - a. The minimum initial lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-90 degree zone - as measured by IESNA Standard LM- 9-0 in an accredited lab. Exact tested output shall be clearly noted on shop drawings.
 - i. 1x4 000 initial lumens 3000k
 - ii. 2x4 3300 initial lumens 3000k
 - b. The lumen output shall not decrease by more than 20 over the minimum operational life of Section 2.2. (or L 0 shall be at least the minimum number of hours as specified in Section 2.2.).
 - c. LED s shall be manufactured by Nichia, Samsung or Osram.
- b) The luminaire performance shall be tested as described herein.
 - a. Luminaire performance shall be judged against the specified minimum illuminance in the specified pattern for a particular application.
 - b. Luminaire lighting performance shall be adjusted (depreciated) for the minimum life expectancy (Section 2.2.).
 - c. The performance shall be adjusted (depreciated) by using the LED manufacturer s data or the data from the IESNA Standard TM-21 test report, which ever one results in a higher level of lumen depreciation.

- c) The luminaire may be determined to be compliant photometrically, if:
 - a. The initial minimum illuminance level is achieved in 100 of the area of the specified lighting pattern
- d) The measurements shall be calibrated to standard photopic calibrations.
- e) Light Color/Quality-
 - a. Correlated Color Temperature (CCT) of 3000K, 3000K, 4000K and 5000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
 - b. Color shift over 10,000 hours shall be 0.00 change in u v as demonstrated in IES LM 0 report.
 - c. The color rendition index (CRI) shall be 90 or greater.

2.3.3 THERMAL MANAGEMENT

- a) The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life (section 2.2.).
- b) The LED manufacturer s maximum junction temperature for the expected life (Section 2.2.) shall not be exceeded at the average operating ambient (Section 2.2.).
- c) The LED manufacturer s maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.
- d) The luminaire shall have an UL IC rating.
- e) The Driver manufacturer s maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed

2.3.4 PHYSICAL AND MECHANICAL REQUIREMENTS

- a) The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit.
- b) Luminaire housing to have no visible welding, screws, springs, hooks, rivets, bare LED s or plastic supports.
- c) The assembly and manufacturing process for the SSL luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.
- d) The optical assembly of the luminaire shall consist of a ribbed metal reflector system and extruded refracting optical lens with high-transmission internal optical film applied to the inside of the refract-

ing lens. No individual LED images shall be visible to the occupant of the space.

- e) The electronics/power supply enclosure shall be internal to the SSL luminaire and be accessible per UL requirements
- f) Lumen Management: The luminaire shall be capable of continuously monitoring system performance to allow for constant lumen management / compensation function. Lumen output to be maintained at 0 for life of the luminaire, initial input to be 0 of rated input watts and climb to rated watts by end of rated life. Energy savings shall be 20 initial and 10 over rated life of luminaire.

2.3. MATERIALS

- a) Luminaire shall be fabricated from post painted cold rolled steel and shall be a rigid structure with integral T-bar clips.
- b) Reflector: rugged one-piece cold rolled steel with embossed multi-facets, echoing the frequency of the refractor prisms to distribute soft light at multiple angles.
- c) Finish: Polyester powder coat painted with 92 high-reflective paint after fabrication.
- d) Refractor or lens shall be 2 piece assembly composed of impact-resistant (20) DR acrylic with optical film overlay to eliminate source image.
- e) Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. Luminaire lenses are excluded from this requirement.

2.3. LUMINAIRE IDENTIFICATION

- a) Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture (month-year), and lot number as identification permanently marked inside the each unit and the outside of each packaging box.
- b) The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere.

2.4 QUALITY ASSURANCE

- 2.4.1 The luminaires shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure performance. These tests shall include: CCT, CRI, Lumen output and wattage. Tests shall be recorded, analyzed and maintained for future reference.

- 2.4.2 QA process and test results documentation shall be kept on file for a minimum period of seven years.
- 2.4.3 LED luminaire designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.

2. DESIGN QUALIFICATION TESTING

- 2. .1 Design Qualification Testing shall be performed by a National Voluntary Laboratory Accreditation Program (NVLAP) testing facility. Such testing may be performed by the manufacturer or an independent testing lab hired by the manufacturer on new luminaire designs, and when a major design change has been implemented on an existing design. A major design change is defined as a design change (electrical or physical) which changes any of the performance characteristics of the luminaire, results in a different circuit configuration for the power supply, or changes the layout of the individual LED's in the module.
- 2. .2 A quantity of two units for each design shall be submitted for Design Qualification Testing.
- 2. .3 Product submittals shall be accompanied by product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):
 - a) Maximum power in Watts
 - b) L₀ in hours, when extrapolated for the worse case operating temperature (section 2.2.). TM21 report shall be submitted to demonstrate this.
 - c) Product submittals shall be accompanied by performance data that is derived in accordance with appropriate IESNA testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products.
- 2. .4 Luminaire shall be tested per IESNA LM 9-0 .

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 01.
- 3.1.2 Fixture to be recessed mounted in suspended lay-in grid ceiling with standard tee, 1/1 or 9/1 tee or screw slot. Contractor to verify exact ceiling type prior to ordering luminaires. Bottom of luminaire to be flush with ceiling.

- 3.1.3 Fixture for recess mounting in drywall to be provided with drywall ceiling adaptor.
- 3.1.4 Install all required hardware and mounting brackets to secure luminaires to structure per local code requirements.
- 3.1. Bond luminaires and metal accessories to branch circuit equipment grounding conductor.

3.2 FIELD QUALITY CONTROL

- 3.2.1 Perform field inspection, testing, and adjusting in accordance with Section 014000.
- 3.2.2 Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- 3.2.3 Test and calibrate all controls associated with luminaires, i.e. integral photo cells and occupancy sensors.

3.3 CLEANING

- 3.3.1 Clean electrical parts to remove conductive and deleterious materials.
- 3.3.2 Remove dirt and debris from lens enclosures
 - a) For cleaning acrylic lenses or diffusers, use a feather duster or dry cotton cheesecloth to rid the lens/diffuser of any minor dust. For fingerprints, smudges, or other dirt present, use an ammonia-based cleaner (such as Windex) and wipe carefully with cotton cheesecloth (so as to avoid injury from any prismatic texture of the lens).
 - b) Job site contamination may not necessarily be removed using the above recommendations. In that case the lens would need to be replaced.
- 3.3.3 Clean photometric control surfaces as recommended by manufacturer.

3.4 CLOSEOUT ACTIVITIES

- 3.4.1 Replace any luminaire components or associated controls which is not function per specifications.

END OF SECTION

SECTION 266000 - LABORATORY ELECTRICAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

- A. The general conditions, Division 1, and Division 26 electrical requirements are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from all other Division 26 sections shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections. For Laboratory areas only (excluding lab lighting), this section shall take precedence.
- C. Provide complete electrical systems from the laboratory branch circuit panelboards to all devices and equipment as described in these specifications and shown on the Laboratory Electrical drawings. Electrical installations shall include all required hardware, fittings, boxes, mounting provisions and miscellaneous equipment to provide complete and operable systems in accordance with the standard practices of the trade. Materials utilized shall be as defined in other sections of Division 26 of these specifications and modified only as described herein.

1.2 EXPLANATION OF DRAWINGS

- A. The Laboratory Electrical (LE) construction documents are intended to be diagrammatic and reflect the scope, quality, and character of the work to be performed; all miscellaneous materials and work required for a complete and operational system, though not specifically mentioned, shall be furnished and installed by the Contractor.
- B. The Contractor shall confirm sizes, dimensions, weights and locations of all devices, light fixtures, and equipment prior to installation. Dimensioned architectural drawings shall take precedence over diagrammatic layouts shown on these contract documents.
- C. The Contractor shall be responsible for reporting any discrepancies, errors, or omissions regarding the Laboratory Electrical drawings noted prior to bid.
- D. It is the intent of the drawings to indicate schematic routing and placement of devices, fixtures, equipment and conduit. Exact locations shall be dimensioned on other trade documents (architectural, laboratory furnishings, mechanical, etc.). Offsets, elbows, or extensions shall be furnished and installed by the Contractor as necessary to avoid structure, piping, clearances and to provide a complete and workmanlike installation.

1.3 QUALITY ASSURANCE AND STANDARDS

- A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications, and supplements, of the following codes and standards or other regulations which may apply:
 - 1. American Disabilities Act (ADA)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Institute of Cable Engineers Association (ICEA)

5. Institute of Electrical and Electronics Engineers (IEEE)
6. Local Code Enforcement Agency Requirements
7. National Electrical Code (NEC)
8. National Electrical Contractor's Association (NECA)
9. National Electrical Manufacturer's Association (NEMA)
10. National Electrical Testing Association (NETA)
11. National Fire Protection Association (NFPA)
12. Underwriters' Laboratories, Inc. (UL)
13. International Building Code (IBC)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, Architect, and Owner's Representative by the Contractor.

- C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.
- D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.
- E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the Contractor.

1.4 SUBMITTALS

- A. Shop drawings for materials, equipment, devices, fixtures, and systems shall be submitted by the Contractor for review in compliance with the requirements of Division 1 and Division 26.
- B. The Contractor shall bear the responsibility for any materials installed which were not submitted for review or not installed in compliance with the review comments and the contract documents.
- C. Verbal modification of submittal documents or changes to the requirements of the contract documents shall not be acceptable. All submittal material must be documented in a written format.
- D. All submittal packages must be submitted at one time and in accordance with the specification section appropriate for the material. All packages must be identical and clearly labeled indicating the specification section, project name, submittal date, Contractor's name, Engineer's name, preparer's name and submission version (first submission, resubmittal #1, etc.)
- E. Product catalog cutsheets and descriptive literature shall be cross-referenced to the specification section by paragraph.
- F. All submittal packages shall be permanently bound in brochure or booklet format. A minimum of six submittal booklets shall be provided by the Contractor; additional copies may be required if so noted.
- G. Materials which bear a certification or approval of a testing agency, performance criteria, society, agency, of other organization shall be submitted with all labels identified.

- H. The submittal shall be complete and with catalog data and information properly marked to show, among other things, materials, capacity and performance data to meet the specified requirements.
- I. Incomplete submittals will be rejected at the discretion of the reviewing Engineer.
- J. Review of the submittal is for general conformance with the contract documents. The Contractor is responsible for confirmation and coordination of dimensions, quantities, sizes, fabrication, installation methods, and for coordination of work of other trades with the electrical work.
- K. Submittal brochures shall be complete and descriptive of the type, make, manufacturer, application, quantity, performance, capacity, ratings, options, dimensions, clearances, weights, nameplate data, special installation requirements, mounting method, NEMA type, NEMA class, environmental restrictions, layout requirements or other information as may be necessary for review of the material.
- L. The Contractor shall be responsible for all aspects of substitutions of material including any additional cost or delay incurred as a result of the substitution. The Contractor shall coordinate all substitutions with other trades, verify code compliance, verify clearances, photometric performance, appearance, suitability, constructability, and availability of the material prior to submitting the substitution for review. The Contractor shall bear the responsibility of any increased costs to other trades which are directly related to the substitution.
- M. Submittals shall include the following:
 - 1. Raceways
 - 2. Wire and Cable
 - 3. Boxes
 - 4. Wiring Devices
 - 5. Disconnect Switches
- N. Submit detailed dimensioned drawings for all multi-outlet surface raceways.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new, of prime quality, listed as suitable for the application, and bear factory-applied U.L. labels.
- B. Materials shall be currently in production and shall be supported by spare parts, repair service, maintenance, and factory technical support

2.2 RACEWAYS

- A. Electrical Metallic Tubing (EMT)
 - 1. Conduit shall be cold rolled zinc coated steel and manufactured per UL and ANSI requirements.
 - 2. Fittings for EMT shall be watertight steel or malleable gripping ring compression type.
 - 3. Pressure cast material for nuts of compression ring type fittings and set-screw connections are not acceptable.
 - 4. Minimum raceway size shall be ¾".
- B. Flexible Metallic Conduit

1. Flexible conduit shall bear the UL label and be zinc-coated steel.
2. Fittings for flexible metallic conduit shall be steel or malleable iron. Fittings shall clamp to conduit securely.
3. Screw in type, sheet metal or set-screw type fittings are not acceptable.
4. Minimum raceway size shall be $\frac{3}{4}$ ".

C. Liquid Tight Flexible Conduit

1. Conduit shall be manufactured in accordance with UL and ANSI requirements. Conduit shall be approved for grounding and compatible with approved fittings. Flexible steel conduit shall be hot dipped galvanized with extruded PVC covering manufactured per UL requirements.
2. Fittings shall be liquid tight type with body and gland nut of steel or malleable iron with provisions for grounding flexible conduit to fittings.
3. Minimum raceway size shall be $\frac{3}{4}$ ".

D. Polyvinyl Chloride (PVC) Conduit

1. PVC shall be constructed of a virgin homopolymer PVC compound and be manufactured according to NEMA and UL specifications. PVC conduit shall be Schedule 40 or 80.
2. Minimum raceway size shall be $\frac{3}{4}$ ".

E. Multi-outlet Surface Raceways

1. Multi-outlet surface raceways shall be furnished complete with bases, covers, end plates, connectors, wiring devices, receptacles, connectors, and labels as indicated on the drawings and in these specifications. The multi-outlet surface raceways may be factory or field assembled.
2. Mounting of multi-outlet surface raceways shall be according to the manufacturer's recommendations and detailed drawings. Specific fitting of the multi-outlet surface raceways to casework, benches, or walls shall be the responsibility of the Contractor. Coordinate elevations with Laboratory Furnishings drawings and details.
3. Refer to the Laboratory Furnishings drawings and specifications for details in regard to the location, length, and quantity of multi-outlet surface raceways.
4. Multi-outlet surface raceways shall fit the intended space with no more than 1/8 inch clearance between each end of the raceway and the adjacent wall, bench, support riser, end of counter, or other laboratory finish as appropriate.
5. Final multi-outlet surface raceway cuts shall be plumb and straight and shall be finished to eliminate burrs, nicks, or sharp edges on both raceways and covers. Multi-outlet surface raceway field cuts which are not equal to the quality and appearance of the factory cuts will be rejected at the discretion of the Laboratory Engineer or Architect.
6. Provide end plates with conduit knock-outs for the conduit sizes indicated or as required by code.
7. All receptacles in multi-outlet surface raceways shall be wired for the entire length of the raceway section with properly tagged pigtails.
8. The multi-outlet surface raceways shall be U.L. listed assemblies.
9. Multi-outlet surface raceway bases, covers, and end plates shall be constructed of extruded aluminum with 0.094" minimum thickness walls and clear anodized finish. The multi-outlet surface raceway extrusion shall be rectangular in cross section and have no protrusions. Multi-channel raceways shall be two compartment, pre-wired Wiremold ALA4500 series, Monosystems SWA4500 series, or equal. Single channel raceways shall be one compartment, pre-wired Wiremold ALA3800 series, Monosystems SWA3200 series, or equal.
10. Multi-outlet surface raceway covers shall be cut in 12-inch sections with one "filler" section of less than 12 inches at only one end of each run of raceway as required.

Receptacle or telecommunications port locations shall only be provided on a 12-inch cover section.

11. Do not scale or dimension Laboratory Electrical drawings to determine raceway lengths. Laboratory Furnishings drawings should be used for this purpose.
12. Provide labeling with panel and circuit number at each receptacle installed in the raceway. Labels may be either engraved phenolic affixed with epoxy, or engraved directly on raceway cover plate. Phenolic labels shall be block with white lettering for normal power receptacles and red with white lettering for standby or emergency power receptacles. Engraved cover plate labels shall have black lettering for normal power receptacles or red lettering for standby or emergency power receptacles.

2.3 WIRE AND CABLE

- A. Conductors shall be copper; conductors size #10AWG and smaller shall be solid, conductors size #8AWG and larger shall be stranded. Conductors shall be minimum size #12AWG for power and lighting circuits; control circuits shall use a minimum conductor size of #14AWG.
- B. Insulation shall be type THW or THHN/THWN for all branch circuits up to and including size #2AWG. Insulation for conductors over size #2AWG shall be XHHW.
- C. Jackets shall be nylon or PVC material.
- D. All cables shall be UL listed for the application.
- E. All conductors shall be installed in conduit in the field, unless specifically noted otherwise in these documents. Type AC, type NM and type MC cable are not acceptable.
- F. Multi-conductor flexible cords shall be types SO, SJO, STO, or SJTO.
- G. Connectors shall be UL listed and suitable for the conductor material being connected or spliced, and rated appropriately. Connectors shall be solderless conical metal spring pressure type ("wire nuts") for conductors #10AWG and smaller. Connectors shall be mechanical compression type for conductors #8AWG and larger. Push-in type connectors ("WAGO"), shall not be used.

2.4 BOXES

- A. Boxes shall be flat rolled steel sized as required by code and as suitable for the application. Boxes shall have mounting holes and knock-outs in sides and back. Grounding shall be accommodated by means of threaded holes.
- B. Provide accessories, extension rings, gaskets, supports, trim rings, hangers, straps, and other material as necessary for a complete code complying installation.
- C. Boxes installed outdoors shall be weather-tight, dust-tight, and corrosion resistant. Provide gaskets and conduit hubs.
- D. Provide Type FS boxes for surface mounted applications.
- E. Provide additional support for boxes as necessary when mounting fixtures or devices from boxes.
- F. Provide ganged boxes for multiple switches and devices; provide barriers for boxes served by separate voltages.

2.5 WIRING DEVICES

A. Receptacles

1. Wiring devices shall be UL listed and suitable for the application.
2. Devices shall be color coded per the system to which they are connected: normal power shall be white; standby or emergency power shall be red; dedicated outlets shall be grey; unless otherwise noted on the construction documents.
3. Receptacles shall be heavy duty, screw type, side wired, 120V, 20A, duplex type, unless noted otherwise on the construction documents. Verify NEMA configuration with construction documents.
4. Weathertight receptacles shall be gasketed in cast metal boxes with cast metal coverplates with spring-loaded hinged covers over each opening.
5. Ground fault interrupting receptacles shall be duplex type and capable of detecting a leaking current of 5mA.

B. Toggle Switches

1. Toggle wall switches shall be quiet AC type, rated 120/277V, 20A and UL listed for the application.
2. Switches shall be single pole, double throw with white finish unless noted otherwise.

C. Coverplates

1. Single, combination coverplates shall be used at all ganged device locations.
2. Provide stainless steel coverplates with matching screws in laboratory, process, manufacturing, and clean room areas or as noted on the construction documents.
3. Provide labeling with panel and circuit number at each receptacle coverplate. Labels may be either engraved phenolic affixed with epoxy, or direct factory engraving on the coverplate. Phenolic labels shall be black with white lettering for normal power receptacles and red with white lettering for standby or emergency power receptacles. Engraved cover plate labels shall have black lettering for normal power receptacles or red lettering for standby or emergency power receptacles.

2.6 POWER AND TELECOMMUNICATIONS PEDESTALS

A. Manufacturer

1. Design is based on WaterSaver pedestal electrical box with 3/4" hub, single-gang catalog number E300SA, two-gang catalog number E400SA and E500SA, and four-gang catalog number E600SA.
2. If alternate product is to be submitted, all material and functional requirements of the specified product must be demonstrated and documented to be equal.

B. Pedestals shall have aluminum base and housing, containing devices as shown on drawings. Housing finish shall be brushed.

C. Faceplates

1. Pedestal receptacle faceplates shall be stainless steel, and shall accommodate the device types and quantities indicated on the drawings. Faceplates shall have engraved labeling with requirements as noted for raceway and coverplate labels.
2. Pedestal telecommunication faceplates shall be stainless steel, and shall be provided with cutouts specifically designed to accommodate the type of tel/data devices to be installed by the telecommunications/data system installer. Coordinate prior to ordering faceplates.

2.7 DISCONNECT SWITCHES

- A. Disconnects shall NEMA 1, indoor type, or rated for the locations in which they are installed as noted on the construction documents.
- B. Disconnects shall be UL listed and suitable for the application.
- C. Disconnects in exterior, wet, cold, warm, or hot environments shall be raintight, have raintight hubs, and be rated NEMA 3R.
- D. Disconnects shall be heavy duty type, rated 600V with current capacity as noted on the construction documents. Verify NEMA configuration with construction documents.
- E. Disconnects shall have hinged, lockable, dead-front doors with permanently marked ON/OFF indicators. Enclosures shall be baked enamel factory painted steel with conduit knockouts.
- F. Disconnects shall be operated by a handle accessible from the exterior of the enclosure. Handles shall have provision to be padlocked in the OFF position.
- G. All current carrying parts shall be high conductivity copper designed to carry rated load without damage from heat and plated to resist corrosion.
- H. Switch mechanism shall be a quick-make, quick-break type such that the operation of the contact is restrained by the handle during the closing or opening operation.
- I. Switches shall have a minimum fault current rating of 200,000A RMS.
- J. All switches shall be fused unless specifically noted otherwise.
- K. The disconnect door cover shall have an interlocking mechanism to prevent opening the cover when the switch is in the ON position.
- L. Fuses serving motor loads shall be Class L and Class RK1, 250V and 600V, time delay, dual element unless noted otherwise on the construction documents.
- M. Fuses serving non-motor loads shall be Class L and Class RK1, 250V and 600V, fast acting, dual element unless noted otherwise on the construction documents.
- N. Provide built-in fuse pullers.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

- A. All laboratory electrical work shall conform to National Electrical Contractors Association standards of installation and the requirements of the manufacturer, Division 1, Division 26, and the Owner's Representative.
- B. The Contractor shall field-verify all dimensions and coordinate dimensions with equipment sizes and locations.
- C. The Contractor shall coordinate and install all penetrations, openings, slots, chases, or sleeves as necessary for the routing and installation of laboratory electrical equipment. The Contractor shall provide approved fire sealant to maintain fire ratings at all penetrations.

- D. The Contractor shall coordinate and cooperate with all other trades for a successful completion of the laboratory electrical work.
- E. The Contractor shall install access panels in walls or ceilings in coordination with the Architect for all laboratory electrical equipment, which require access.
- F. All laboratory electrical equipment shall be installed plumb, parallel, or orthogonal to structure and in a neat orderly fashion. All material shall be accessible for maintenance, inspection, servicing or replacement.
- G. Verify final locations for laboratory electrical devices and equipment during the rough-in phase with dimensioned architectural drawings, fabrication drawings, or other space planning requirements included in the contract documents.
- H. The Contractor shall provide adequate and qualified supervision for the work performed; no work shall be performed without the supervision of a representative of the Contractor.

3.2 GROUNDING AND BONDING

A. Special Cabinets

- 1. At all flammable materials storage cabinets, solvent storage cabinets, corrosive storage cabinets and gas safety cabinets, provide a (minimum) #12 AWG copper, insulated green grounding conductor from the equipment grounding conductor of the nearest available 120 volt circuit outlet box.
- 2. Extend cabinet bonding conductor from the nearest circuit outlet box via ½" conduit concealed in wall and stubbed out behind the respective cabinet. Conduit shall be converted to flexible metal conduit where exposed, and shall terminate with a UL listed bushing. Where indicated on the drawings, provide a flush wall box with cover plate (with grommeted hole, ½" diameter) and extend bonding conductor from wall box to equipment terminal.
- 3. The bonding conductor shall be secured to the bonding terminal of the cabinet. If the cabinet is not equipped with a bonding terminal, provide a UL listed screw terminal and permanently secure it to the metallic cabinet with a screw, lockwasher and bolt. Self-tapping sheet metal screws will not be accepted as the means of attachment.
- 4. Refer to the Lab Furnishings (LF) specifications and drawings for cabinet specs, details, quantities and locations. Bonding shall be provided at each cabinet whether or not specifically indicated at each cabinet location.

B. Grounding Bus at Storage Rooms

- 1. Where indicated on the drawings, provide copper bus bar assemblies, wall mounted on insulator bushings, secured to the building framing structures.
- 2. For each area containing a ground bus bar system, provide a dedicated conduit homerun to the respective branch circuit panel serving the area. Install an insulated copper grounding conductor (green color).
- 3. Provide listed fittings, nuts, bolts, connectors and miscellaneous hardware for a complete ground bus system.

3.3 COMMISSIONING

- A. The Contractor shall initiate start up of all laboratory electrical equipment including operation of all devices, switches, overcurrent protection, disconnect switches, etc. to verify normal operation of all moving parts and electrical performance.

- B. The Contractor shall test, adjust, align, label, clean and complete all systems prior to acceptance by the Owner's Representative.
- C. The Contractor shall demonstrate that all systems operate within the manufacturer's recommended performance characteristics, the laboratory electrical construction documents, system requirements, and Owner requirements.
- D. The Contractor shall test each laboratory electrical system per the manufacturer's requirements and shall perform the following system tests:
 - 1. Inspect cables for physical damage and proper connection.
 - 2. Torque test cable connection and tighten in accordance with termination manufacturers recommendations.
 - 3. Infrared scan all connections under loaded conditions and provide color printed images.
 - 4. Insulation resistance test of each cable.
 - 5. Inspect ground system connections.
 - 6. Voltage drop tests on the main grounding electrode of system.
 - 7. Determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral points.
 - 8. Check rated voltage and phase balance at all equipment, motors and selected devices at full load conditions. Measure no load voltage conditions at each location.
 - 9. Furnish all material, equipment, instruments and labor as required to complete testing.
 - 10. Provide all test results properly bound in a three-ring binder.

3.4 CLEANING

- A. Contractor shall clean all equipment, conduit interiors, fixtures, devices, etc. of all extraneous paint, drywall mud, overspray, dust, dirt, debris, trash, grease or markings. All cleaning shall be performed by the Contractor in accordance with the appropriate manufacturer's recommendations.

3.5 RACEWAYS

- A. EMT shall be run indoors concealed in drywall type construction, above suspended ceilings, or in utility chases at casework or lab benches. In unfinished indoor areas, EMT shall be run exposed no less than 8'0" above finished floor.
- B. EMT shall not be installed underground or embedded in concrete.
- C. Flexible conduit shall not exceed 6'0" in length.
- D. Flexible conduit used for final connection to laboratory equipment shall not exceed 2'0" in length.
- E. The conduit grounding system shall be continuous as recommended by the manufacturer and UL approved.
- F. Liquidtight flexible conduit shall be used for final connection to machines, motors, transformers and equipment that requires vibration isolation.
- G. Liquidtight flexible conduit shall be used for final connection to equipment in wet or damp locations or where exposed to grease, water, dust, dirt, pathogens, vapors, or chemicals.

3.6 WIRE AND CABLE

- A. All wiring methods shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.

- B. Conductors shall be installed in clean raceways using nylon cord, polypropylene cord, hemp rope, or other material, which will not damage the conductors or conduit. Do not use metal fish tape. Use lubricant when necessary for pulling.
- C. Conductors shall be pulled into conduit simultaneously so as to not damage conductors during pulling.
- D. Conductors installed at outlets and switches shall have a minimum of 6" pigtail left in the box for future connections. All conductors not connected to devices shall be terminated with splice caps and tape.
- E. Conductors shall be terminated such that no copper material is exposed. Conductors shall be trained and labeled at terminations in a neat and workmanlike manner.
- F. All terminations shall be mechanically sound, featuring helical twisting of the terminating conductors prior to the application of an electrical connector. The electrical connector shall not be used for the mechanical connection of the conductors.
- G. All terminations shall comply with the manufacturer's installation and torquing requirements.
- H. Splices on conductors #10AWG and smaller shall be made with splice caps twisted onto the conductors. Tape all splices.
- I. Splices on conductors #8AWG and larger shall be made with pressure connectors and terminal lugs. Where exposed to water, damp air, or moisture, splices shall be watertight.
- J. Splices shall not be made in feeders; splices to branch circuits shall not be made within panelboards or similar enclosures.
- K. When combining homeruns, the Contractor shall derate all conductors per code requirements including reducing the ampacity, using high temperature insulation where necessary. Conduit sizes shall be adjusted by the Contractor as suitable for the conductor revisions.
- L. The Contractor shall provide a code-sized insulated ground conductor, in addition to the feeder conductors indicated on the drawings, where non-metallic conduit is used.
- M. Conductors shall be color-coded as follows or as matches the building standard:

208Y/120V	Phase	480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

- N. Where tape or labels are used for color-coding, apply material at each end of the conductor, splices, boxes, and all terminations.

3.7 BOXES

- A. All box installation methods shall comply with the latest enforced edition of the National Electrical Code and the authority having jurisdiction.
- B. Install all boxes plumb, square, and securely fastened to structure.

- C. Boxes shall be placed such that they are readily accessible.
- D. Cover or plug all unused openings in boxes where knockout blanks have been removed.
- E. Install boxes such that they are flush with the finished surface of the wall or surface within which they are mounted.
- F. Install all boxes at mounting heights per architectural, electrical code, and ADA requirements.
- G. Boxes shall not be mounted back to back in walls.
- H. Boxes in sealed environments shall be sealed with an approved sealant suitable for the application.
- I. Boxes penetrating fire rated walls or surfaces shall be sealed with a Fire Marshal approved fire sealant to maintain the fire rating of the wall or surface.
- J. Boxes located above inaccessible ceilings shall be made accessible by means of access doors or hatches in the ceiling.
- K. Install all boxes per manufacturer's recommendations and requirements.
- L. Provide for ground continuity at all boxes.

3.8 WIRING DEVICES

- A. Installation methods for wiring devices shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.
- B. Install all devices in accordance with the manufacturer's recommendations and requirements.
- C. Coordinate device mounting height, location and type with architectural and interior drawings. Coordinate with other trades to identify conflicts with device locations and notify the Engineer of any conflicts.
- D. Install devices only in clean boxes.
- E. Install all trim rings and coverplates in coordination with other trades and their installation schedules.
- F. Tighten and inspect all connections prior to covering devices and reconnect or repair wiring as necessary.
- G. Test all devices for voltage level, continuity, ground fault, and short circuits.
- H. Install all devices plumb and square to structure and adjacent surfaces.
- I. Connect and inspect all ground bonds prior to covering device.
- J. Demonstrate the proper operation of all ground fault interrupting devices.

3.9 DISCONNECT SWITCHES

- A. Installation methods for disconnects shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.
- B. Install all disconnects in accordance with the manufacturer's recommendations and requirements.

- C. Coordinate disconnect mounting height, location and type with architectural and interior drawings. Coordinate with other trades to identify conflicts with device locations and notify the Engineer of any conflicts. Mount switches 42" above finished floor unless noted otherwise.
- D. Provide suitable galvanized metal strut framework where no wall or structure is available for the mounting of disconnects.
- E. Provide flexible conduit connections for disconnects mounted to strut framework, motors, or vibrating equipment.
- F. Tighten and inspect all connections and reconnect or repair wiring as necessary.
- G. Test all disconnects for voltage level, continuity, ground fault, and short circuits. Check switch mechanism operation under no load conditions prior to operating under load.
- H. Install all disconnects plumb and square to structure and adjacent surfaces.
- I. Provide and install all fuses sized per the equipment manufacturer's recommendation.

END OF SECTION 266000

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 OBJECTIVE:

- A. Basic Communications Requirements - The objective of this project is to provide a Panduit TX A 10G 2 year Certification Plus System Warranty , and other auxiliary equipment for a complete system in accord with the plans and specification. The bid shall include all labor, material, testing, etc. to provide a complete finished product, including the demolition of any unused existing cabling, outlets, boxes and the other equipment no longer in service and as directed by the owner.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathways and cables.
 - 2. Sleeve seals.
 - 3. Grout.
 - 4. Common communications installation requirements.

1.3 SUBMITTALS

- A. Product Data: For sleeve seals.

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 3/A 3M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 12 0 mm (0 inches) and no side more than 400 mm (1 inches), thickness shall be 1.3 mm (0.0 2 inch).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 12 0 mm (0 inches) and 1 or more sides equal to, or more than, 400 mm (1 inches), thickness shall be 3. mm (0.13 inch).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Manufacturers: Subject to compliance with requirements and available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products Systems, Inc.

- b. Calpico, Inc.
- c. Metraflex Co.
- d. Pipeline Seal and Insulator, Inc.
- 2. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
- 3. Pressure Plates: Stainless steel. Include two for each sealing element.
- 4. Connecting Bolts and Nuts: Stainless steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 110 , factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.

- F. Extend sleeves installed in floors 0 mm (2 inches) above finished floor level.
- G. Size pipe sleeves to provide .4-mm (1/4-inch) annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 0 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 0 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 2 -mm (1-inch) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 2 -mm (1-inch) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 0 Section "Penetration Firestopping."

END OF SECTION 27 05 00

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Telecommunications mounting elements.
 - 2. Backboards.
 - 3. Telecommunications equipment racks.
 - 4. Grounding.
- B. Related Sections:
 - 1. Division 2 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- D. LAN: Local area network.
- E. RCDD: Registered Communications Distribution Designer.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE .
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1. SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- D. Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
1. QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - B. Telecommunications Pathways and Spaces: Comply with TIA/EIA- 568-A.
 - C. Grounding: Comply with ANSI-J-STD- 0 -A.
1. PROJECT CONDITIONS
- A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.
1. COORDINATION
- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 2. Record agreements reached in meetings and distribute them to other participants.
 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. General Requirements: Comply with TIA/EIA- 9-A.
- B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
1. Comply with NFPA 0 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
 2. Support brackets with cable tie slots for fastening cable ties to brackets.
 3. Lacing bars, spools, J-hooks, and D-rings.
 4. Straps and other devices.
- C. Cable Trays:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Wyr-Grid
 2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0. , not less than 0.0 mm (0.0021 inch) thick.
 - a. Basket Cable Trays: 30 mm (1 inches) wide and 100 mm (4 inches) deep. Wire mesh spacing shall not exceed 0 by 100 mm (2 by 4 inches).
 - b. Ladder Cable Trays: LadderRack, Nominally 30 mm (12 inches) wide, and a rung spacing of 30 mm (12 inches), black
- D. Conduit and Boxes: Comply with requirements in Division 2 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
1. Outlet boxes shall be no smaller than 4-11/16 inches square by 2-1/4 inches deep.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, plugged and sanded on one side, 19 by 1220 by 2440 mm (3/4 by 4 by 9 inches). Comply with requirements for plywood backing panels specified in Division 0 Section "Rough Carpentry." Provide backboard on all walls of each MDF and IDF room.

2.3 EQUIPMENT FRAMES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Chatsworth Products, Inc.
- B. General Frame Requirements:
 - 1. Distribution Frames: Freestanding modular aluminum extrusion units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Module Dimension: Width compatible with EIA 310 standard, 400-mm (19-inch) panel mounting. Height shall be 400 and depth shall be 300.
 - 3. Finish: Manufacturer's standard, epoxy-polyester hybrid powder coat.
- C. Floor-Mounted Racks: Modular-type aluminum extrusion construction. Chatsworth 433-03
 - 1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
 - 2. Black epoxy-polyester hybrid powder coat finish.
 - 3. UL listed for 1000 lb. loading.
 - 4. Shall accept Panduit cable management and patch panel products.
- D. Cable Management for Equipment Frames:
 - 1. Metal, with integral wire retaining fingers.
 - 2. Epoxy-polyester hybrid powder coat finish.
 - 3. Vertical Management Patchrunner 2 (PR2V)
 - 4. Horizontal Management - Front Rear

2.4 POWER

- A. Power Strips: Comply with UL 133.
 - 1. Rack mounting. Panduit G PDU
 - 2. 30A, L-30P, (20)-C13, and (4)-C19
 - 3. LED indicator lights for power and protection status.
 - 4. LED indicator lights for reverse polarity and open outlet ground.
 - . Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
 - . Close-coupled, direct plug-in line cord. Cord shall be 10ft.
 - . Rocker-type on-off switch, illuminated when in on position.
 - . Peak Single-Impulse Surge Current Rating: 13 kA per phase.
 - 9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.
- B. IDF UPS: APC Smart UPS, 3000VA, 120V, 90% efficiency, Ethernet card, temperature probe. Provide () -1 R outputs.

2. GROUNDING

- A. Comply with requirements in Division 2 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

- B. Telecommunications Main Bus Bar:
 - 1. Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
 - 2. Ground Bus Bar: Copper, minimum 0.2 thick by 20 wide by 4 high. 30 attachment points (2 rows of 1) for 2 hole lugs
 - 3. Stand-Off Insulators: Comply with UL 91 for use in switchboards, 00 V. Lexan or PVC, impulse tested at 000 V.
- C. Comply with ANSI-J-STD- 0 -A.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA- 9-A- .
- D. Pathway Installation in Communications Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard when entering room from overhead.
 - 4. Extend conduits mm (3 inches) above finished floor.
 - . Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 2440-mm (9 -inch) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 FIRESTOPPING

- A. Comply with requirements in Division 0 Section "Penetration Firestopping." Comply with TIA/EIA- 9-A, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD- 0 -A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 0-mm (2-inch) clearance behind the grounding bus bar.

Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. AWG equipment grounding conductor.
 - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA- 0 -A. Comply with requirements in Division 2 Section "Identification for Electrical Systems". Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label. Pathways and racks also require identification.
- B. See Division 2 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA- 0 -A for Class 3 level of administration.
- C. Labels shall be preprinted or computer-printed type. Label each cable end with computer generated permanent ink permanent label per standard labeling scheme
- D. Comply with owner s standards and verify prior to start of work.

END OF SECTION 27 11 00

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Pathways.

B. Related Sections:

- 1. Division 2 Section "Communications Equipment Room Fittings" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- D. LAN: Local area network.
- E. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.
- F. TIA: Telecommunications Industry Association.
- G. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 2 or less.
 - 2. Smoke-Developed Index: 0 or less.
- B. Telecommunications Pathways and Spaces: Comply with NFPA 70 and TIA/EIA-94-A.
- C. Grounding: Comply with NFPA 70 and ANSI-J-STD-001-A.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. General Requirements: Comply with NFPA 70 and TIA/EIA- 9-B.
- B. Cable Trays:
 - 1. See Division 2 Section Communications Equipment Room Fittings for Cable Tray Requirements.
- C. Conduit and Boxes: Comply with requirements in Division 2 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
 - 1. Outlet boxes shall be no smaller than 4-11/16 inches square by 2-1/4 inches deep.

2.2 GROUNDING

- A. Comply with requirements in Division 2 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors. 1/2" X 2" TGB, compression lugs, equipment jumper, rack ground bar, cable runway ground strap.
- B. Comply with NFPA 70 Article 250 and ANSI-J-STD-001-A.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA- 9-A.
- B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 2 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
- C. Comply with TIA/EIA- 9-A for pull-box sizing and length of conduit and number of bends between pull points.
- D. Comply with requirements in Division 2 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- E. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- F. Backboards: Install backboards with 9 1/2-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.
 - 1.

3.2 FIRESTOPPING

- A. Comply with requirements in Division 0 Section "Penetration Firestopping."
- B. Comply with TIA/EIA- 9-A, Annex A, "Firestopping."

c. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD- 0 -A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (0-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 2 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. AWG equipment grounding conductor.

3.4 IDENTIFICATION

A. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. Paint and label colors for equipment identification shall comply with TIA/EIA- 0 -A for Class 2 level of administration, including optional identification requirements of this standard.

END OF SECTION 27 15 00

SECTION 283100 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes fire alarm systems.

1.3 DEFINITIONS

- A. FACP: Fire alarm control panel.
- B. LED: Light-emitting diode.
- C. NICET: National Institute for Certification in Engineering Technologies.
- D. Definitions in NFPA 2 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

- A. Noncoded, addressable system multiplexed signal transmission dedicated to fire alarm service only.
 - 1. Interface with existing fire alarm system.
- B. Noncoded, analog-addressable system automatic sensitivity control of certain smoke detectors and multiplexed signal transmission dedicated to fire alarm service only.
 - 1. Interface with existing fire alarm system.

1. PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 2.

- B. Premises protection includes building construction and occupancy type.
 - C. Fire alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Verified automatic alarm operation of smoke detectors.
 - . Automatic sprinkler system water flow.
 - . Fire standpipe system.
 - D. Fire alarm signal shall initiate the following actions:
 - 1. Alarm notification appliances shall operate continuously.
 - 2. Identify alarm at the FACP and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station
 - 4. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
 - . Close smoke dampers in air ducts of system serving zone where alarm was initiated.
 - . Record events in the system memory.
 - . Record events by the system printer.
 - E. Supervisory signal initiation shall be by one or more of the following devices or actions:
 - 1. Operation of a fire-protection system valve tamper.
 - F. System trouble signal initiation shall be by one or more of the following devices or actions:
 - 1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
 - 2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
 - G. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.
1. SUBMITTALS
- A. Product Data: For each type of product indicated.
 - B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire alarm system design.
 - b. Fire alarm certified by NICET, minimum Level III.
 2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
 3. Device Address List: Coordinate with final system programming.
 4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
 - . Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
 - . Batteries: Size calculations.
 - . Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - . Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 01 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.
- F. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 2 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 2 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
 - a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
 - b. Electronic media may be provided to Architect, and authorities having jurisdiction.

1. QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Work of this Section be performed by a UL-listed company.
- C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level II, III.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 0, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. PROJECT CONDITIONS

- A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of fire alarm service.
 2. Do not proceed with interruption of fire alarm service without Owner's written permission.

1.9 SEQUENCING AND SCHEDULING

- A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put

into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

- B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 - 3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
 - 4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
 - . Keys and Tools: One extra set for access to locked and tamperproofed components.
 - . Audible and Visual Notification Appliances: One of each type installed.
 - . Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. FACP and Equipment: Is an existing Edwards EST3 system
 - 2. Wire and Cable: New wire to match existing.
 - 3. Audible and Visual Signals: New devices to match existing.

2.2 MANUAL FIRE ALARM BOXES

- A. Description: UL 3 listed finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of

operation. Mounted on recessed outlet box if indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.

2.3 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 2 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Multipurpose type, containing the following:
 - a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - b. Piezoelectric sounder rated at dBA at 10 feet (3 m) according to UL 4 4.
 - c. Heat sensor, combination rate-of-rise and fixed temperature.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
 - . Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - . Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
 - . Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
 - a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 1 or 20 deg F (or 11 deg C) per minute.

- b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 13 or 1 deg F (or deg C).
- c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2. and 3. percent/foot (0.00 and 0.011 percent/mm) smoke obscuration when tested according to UL 2 A.

C. Ionization Smoke Detector:

1. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
2. Detector Sensitivity: Between 0. and 1. percent/foot (0.001 and 0.00 percent/mm) smoke obscuration when tested according to UL 2 A.

D. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

- a. Sensor: LED or infrared light source with matching silicon-cell receiver.
- b. Detector Sensitivity: Between 2. and 3. percent/foot (0.00 and 0.011 percent/mm) smoke obscuration when tested according to UL 2 A.

2. Ionization Smoke Detectors:

- a. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
- b. Detector Sensitivity: Between 0. and 1. percent/foot (0.001 and 0.00 percent/mm) smoke obscuration when tested according to UL 2 A.

3. UL 2 A listed, operating at 24-V dc, nominal.

4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

- . Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

- a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 2 0 requirements for Type 4X.
 - . Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - . Integral Visual-Indicating Light: LED type. Indicating detector has operated, and power-on status. Provide remote status and alarm indicator and test station where indicated.
 - . Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
9. Each sensor shall have multiple levels of detection sensitivity.
10. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
11. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.4 HEAT DETECTORS

- A. General: UL 21 listed.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 130 deg F (45 deg C) or rate-of-rise of temperature that exceeds 1 deg F (0.5 deg C) per minute, unless otherwise indicated.
 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (85 deg C).
 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
- D. Continuous Linear Heat-Detector System: Consists of detector cable and control unit.
 1. Detector Cable: Rated detection temperature 130 deg F (55 deg C). Listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator

wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short circuit wires at the location of elevated temperature.

2. Control Unit: Two-zone or multizone unit as indicated. Provides same system power supply, supervision, and alarm features as specified for the central FACP.
3. Signals to the Central FACP: Any type of local system trouble is reported to the central FACP as a composite "trouble" signal. Alarms on each detection zone are individually reported to the central FACP as separately identified zones.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2. NOTIFICATION APPLIANCES

- A. Description: Equipped for mounting as indicated and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
- B. Bells: Electric-vibrating, 24-V dc, under-dome type with provision for housing the operating mechanism behind the bell. Bells shall produce a sound-pressure level of 94 dBA, measured 10 feet (3 m) from the bell. 10-inch (254-mm) size, unless otherwise indicated. Bells are weatherproof where indicated.
- C. Chimes, Low-Level Output: Vibrating type, 105-dBA minimum rated output.
- D. Chimes, High-Level Output: Vibrating type, 115-dBA minimum rated output.
- E. Horns: Electric-vibrating-polarized type, 24-V dc with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.
- F. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25.4-mm-) high letters on the lens.
 1. Rated Light Output: 110 candela.
 2. Strobe Leads: Factory connected to screw terminals.
- G. Voice/Tone Speakers:
 1. UL 1480 listed.
 2. High-Range Units: Rated 2 to 1 W.
 3. Low-Range Units: Rated 1 to 2 W.

4. Mounting: Flush, semirecessed, or surface mounted bidirectional as indicated.
 - . Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2. SPRINKLER SYSTEM REMOTE INDICATORS

- A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2. WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 0, Article 0.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 1 AWG size as recommended by system manufacturer.
 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 0 Article 0, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 219 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 00-V rated, deg C, color-coded insulation.
 1. Low-Voltage Circuits: No. 1 AWG, minimum.
 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 3. Multiconductor Armored Cable: NFPA 0 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 219 for a 2-hour rating.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Smoke or Heat Detector Spacing:
 - 1. Smooth ceiling spacing shall not exceed 30 feet (9 m), the rating of the detector.
 - 2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 2.
 - 3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 2.
- B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
- C. Duct Smoke Detectors: Comply with NFPA 2 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.
- D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- E. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- G. Audible Alarm-Indicating Devices: Install not less than 4 inches (103 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 4 inches (103 mm) below the ceiling.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 WIRING INSTALLATION

- A. Install wiring according to the following:

1. NECA 1.
 2. TIA/EIA -A.
- B. Wiring Method: Install wiring in metal raceway according to Division 2 Section "Raceway and Boxes for Electrical Systems."
1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 2. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch (25.4-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 2 Section "Identification for Electrical Systems."
- B. Install instructions frame in a location visible from the FACP.
- C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

- A. Ground the FACP and associated circuits comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 2.
 - 2. Perform each electrical test and visual and mechanical inspection listed in NFPA 2. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
 - a. Include the existing system in tests and inspections.
 - 3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
 - 4. Testing: Follow procedure and record results complying with requirements in NFPA 2.

- a. Detectors that are outside their marked sensitivity range shall be replaced.
- . Test and Inspection Records: Prepare according to NFPA 2, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 0.

3. ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.
- B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 2. Perform tests and inspections listed for three monthly, and one quarterly, periods.
- C. Semiannual Test and Inspection: Six months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 2. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 2. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3. DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 2 3100