TECHNICAL SPECIFICATIONS

WINDWARD COMMUNITY COLLEGE

VET TECH FACILITY

UNIVERSITY OF HAWAI’I
KANEOHE CAMPUS, OAHU, HAWAII

PROJECT NO.: SW-12-6238

6 JULY 2012

This work was prepared by me or under my supervision and construction of the project will be under my observation. Expiration date 04/30/14.
# TECHNICAL SPECIFICATIONS

## TABLE OF CONTENTS

WINDWARD COMMUNITY COLLEGE  
VET TECH FACILITY  

UNIVERSITY OF HAWAII  
KANEHOE CAMPUS, OAHU, HAWAII  

PROJECT NO. SW-12-6238

<table>
<thead>
<tr>
<th>SECTION NO.</th>
<th>TITLE</th>
<th>PAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TABLE OF CONTENTS .........................................................</td>
<td>1 – 5</td>
</tr>
<tr>
<td></td>
<td>DIVISION 1  GENERAL REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>SECTION 01001</td>
<td>GENERAL REQUIREMENTS ...............................................</td>
<td>1 – 4</td>
</tr>
<tr>
<td>SECTION 01010</td>
<td>SUMMARY OF WORK .....................................................</td>
<td>1 – 9</td>
</tr>
<tr>
<td>SECTION 01040</td>
<td>COORDINATION .................................................................</td>
<td>1 – 5</td>
</tr>
<tr>
<td>SECTION 01100</td>
<td>ADDITIVE BID ITEMS ..................................................</td>
<td>1 – 2</td>
</tr>
<tr>
<td>SECTION 01151</td>
<td>UNIT PRICES .................................................................</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 01300</td>
<td>SUBMITTALS .................................................................</td>
<td>1 – 8</td>
</tr>
<tr>
<td>SECTION 01323</td>
<td>PHOTOGRAPHIC DOCUMENTATION .......................................</td>
<td>1 – 4</td>
</tr>
<tr>
<td>SECTION 01400</td>
<td>QUALITY CONTROL .........................................................</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 01500</td>
<td>CONSTRUCTION FACILITIES ...........................................</td>
<td>1 – 2</td>
</tr>
<tr>
<td>SECTION 01567</td>
<td>POLLUTION CONTROL ....................................................</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 01600</td>
<td>PRODUCT REQUIREMENTS - GENERAL ..................................</td>
<td>1 – 13</td>
</tr>
<tr>
<td>SECTION 01610</td>
<td>PRODUCT REQUIREMENTS - FASTENERS &amp; ANCHORS .................</td>
<td>1 – 5</td>
</tr>
<tr>
<td>SECTION 01700</td>
<td>CONTRACT CLOSEOUT ......................................................</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 01715</td>
<td>EXISTING CONDITIONS – HAZARDOUS MATERIALS SURVEY ............</td>
<td>1 – 1</td>
</tr>
<tr>
<td>SECTION 01735</td>
<td>CUTTING &amp; PATCHING ..................................................</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 01740</td>
<td>CLEANING .......................................................................</td>
<td>1 – 4</td>
</tr>
<tr>
<td></td>
<td>DIVISION 2  SITE CONSTRUCTION</td>
<td></td>
</tr>
<tr>
<td>SECTION 02220</td>
<td>SITE DEMOLITION ..............................................................</td>
<td>1 – 4</td>
</tr>
<tr>
<td>SECTION 02363</td>
<td>TERMITE CONTROL – SS BARRIER SYSTEMS ..........................</td>
<td>1 – 3</td>
</tr>
<tr>
<td></td>
<td>DIVISION 3  CONCRETE</td>
<td></td>
</tr>
<tr>
<td>SECTION 03100</td>
<td>CONCRETE FORMWORK .......................................................</td>
<td>1 – 4</td>
</tr>
<tr>
<td>SECTION 03150</td>
<td>CONCRETE ACCESSORIES ...................................................</td>
<td>1 – 5</td>
</tr>
<tr>
<td>SECTION 03200</td>
<td>CONCRETE REINFORCEMENT .............................................</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 03300</td>
<td>CAST-IN-PLACE CONCRETE ..............................................</td>
<td>1 – 10</td>
</tr>
<tr>
<td>SECTION NO.</td>
<td>TITLE</td>
<td>PAGES</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>SECTION 03350</td>
<td>CONCRETE FINISHING</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 03480</td>
<td>PRECAST CONCRETE SPECIALTIES</td>
<td>1 – 5</td>
</tr>
<tr>
<td>SECTION 03700</td>
<td>CONCRETE REPAIR</td>
<td>1 – 4</td>
</tr>
<tr>
<td>DIVISION 4</td>
<td>MASONRY</td>
<td></td>
</tr>
<tr>
<td>SECTION 04220</td>
<td>CONCRETE MASONRY UNITS</td>
<td>1 – 13</td>
</tr>
<tr>
<td>DIVISION 5</td>
<td>METALS</td>
<td></td>
</tr>
<tr>
<td>SECTION 05080</td>
<td>SHOP-APPLIED FINISHES FOR METAL</td>
<td>1 – 4</td>
</tr>
<tr>
<td>SECTION 05120</td>
<td>STRUCTURAL STEEL</td>
<td>1 – 11</td>
</tr>
<tr>
<td>SECTION 05310</td>
<td>STEEL DECK</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 05400</td>
<td>COLD-FORMED METAL FRAMING</td>
<td>1 – 8</td>
</tr>
<tr>
<td>SECTION 05500</td>
<td>METAL FABRICATIONS – COMMON WORK RESULTS</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 05501</td>
<td>METAL FABRICATIONS – STEEL</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 05503</td>
<td>METAL FABRICATIONS – STAINLESS STEEL</td>
<td>1 – 3</td>
</tr>
<tr>
<td>DIVISION 6</td>
<td>WOOD &amp; PLASTICS</td>
<td></td>
</tr>
<tr>
<td>SECTION 06070</td>
<td>WOOD TREATMENT</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 06100</td>
<td>ROUGH CARPENTRY</td>
<td>1 – 4</td>
</tr>
<tr>
<td>SECTION 06640</td>
<td>PLASTIC PANELING</td>
<td>1 – 4</td>
</tr>
<tr>
<td>DIVISION 7</td>
<td>THERMAL &amp; MOISTURE PROTECTION</td>
<td></td>
</tr>
<tr>
<td>SECTION 07051</td>
<td>MOISTURE PROTECTION – COMMON WORK RESULTS</td>
<td>1 – 10</td>
</tr>
<tr>
<td>SECTION 07190</td>
<td>WATER REPELLENTS</td>
<td>1 – 8</td>
</tr>
<tr>
<td>SECTION 07210</td>
<td>BUILDING INSULATION</td>
<td>1 – 5</td>
</tr>
<tr>
<td>SECTION 07220</td>
<td>ROOF &amp; DECK INSULATION</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 07240</td>
<td>EXTERIOR &amp; INSULATION &amp; FINISH SYSTEMS</td>
<td>1 – 12</td>
</tr>
<tr>
<td>SECTION 07262</td>
<td>VAPOR RETARDERS – BELOW GRADE</td>
<td>1 – 4</td>
</tr>
<tr>
<td>SECTION 07550</td>
<td>MODIFIED BITUMINOUS MEMBRANE ROOFING</td>
<td>1 – 10</td>
</tr>
<tr>
<td>SECTION 07600</td>
<td>FLASHING &amp; SHEET METAL</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 07900</td>
<td>JOINT SEALERS</td>
<td>1 – 10</td>
</tr>
<tr>
<td>DIVISION 8</td>
<td>DOORS &amp; WINDOWS</td>
<td></td>
</tr>
<tr>
<td>SECTION 08110</td>
<td>HOLLOW METAL DOORS &amp; FRAMES</td>
<td>1 – 5</td>
</tr>
<tr>
<td>SECTION 08700</td>
<td>HARDWARE</td>
<td>1 – 15</td>
</tr>
<tr>
<td>SECTION 08712</td>
<td>ELECTRONIC ACCESS CONTROL</td>
<td>1 – 17</td>
</tr>
<tr>
<td>SECTION 08800</td>
<td>GLAZING</td>
<td>1 – 13</td>
</tr>
<tr>
<td>SECTION 08995</td>
<td>GLAZED METAL FRAMING SYSTEMS</td>
<td>1 – 13</td>
</tr>
<tr>
<td>DIVISION 9</td>
<td>FINISHES</td>
<td></td>
</tr>
<tr>
<td>SECTION 09100</td>
<td>METAL SUPPORT ASSEMBLIES</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION NO.</td>
<td>TITLE</td>
<td>PAGES</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>SECTION 09250</td>
<td>GYPSUM BOARD</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 09510</td>
<td>ACOUSTICAL CEILINGS</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 09610</td>
<td>FLOORING TREATMENT</td>
<td>1 – 9</td>
</tr>
<tr>
<td>SECTION 09650</td>
<td>RESILIENT FLOORING</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 09675</td>
<td>SEAMLESS EPOXY-QUARTZ FLOORING</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 09900</td>
<td>PAINTS &amp; COATINGS</td>
<td>1 – 11</td>
</tr>
<tr>
<td>DIVISION 10</td>
<td>SPECIALTIES</td>
<td></td>
</tr>
<tr>
<td>SECTION 10220</td>
<td>LOUVERED EQUIPMENT ENCLOSURES</td>
<td>1 – 5</td>
</tr>
<tr>
<td>SECTION 10260</td>
<td>WALL &amp; CORNER GUARDS</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 10400</td>
<td>IDENTIFYING DEVICES</td>
<td>1 – 2</td>
</tr>
<tr>
<td>DIVISION 11</td>
<td>EQUIPMENT</td>
<td></td>
</tr>
<tr>
<td>SECTION 11601</td>
<td>LABORATORY EQUIPMENT</td>
<td>1 – 12</td>
</tr>
<tr>
<td>DIVISION 12</td>
<td>FURNISHINGS</td>
<td></td>
</tr>
<tr>
<td>SECTION 12350</td>
<td>SPECIALTY CASEWORK</td>
<td>1 – 7</td>
</tr>
<tr>
<td>DIVISION 13</td>
<td>SPECIAL CONSTRUCTION</td>
<td></td>
</tr>
<tr>
<td>SECTION 13185</td>
<td>KENNELS &amp; ANIMAL SHELTERS</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 13282</td>
<td>LEAD-CONTAINING PAINT</td>
<td>1 – 2</td>
</tr>
<tr>
<td>SECTION 13930</td>
<td>WET-PIPE FIRE-SUPPRESSION SPRINKLERS</td>
<td>1 – 20</td>
</tr>
<tr>
<td>DIVISION 14</td>
<td>CONVEYING SYSTEMS (NOT USED)</td>
<td></td>
</tr>
<tr>
<td>DIVISION 15</td>
<td>MECHANICAL</td>
<td></td>
</tr>
<tr>
<td>SECTION 15062</td>
<td>HANGERS &amp; SUPPORTS PIPING &amp; EQUIPMENT</td>
<td>1 – 10</td>
</tr>
<tr>
<td>SECTION 15072</td>
<td>VIBRATION &amp; SEISMIC CONTROLS FOR FIRE</td>
<td>1 – 8</td>
</tr>
<tr>
<td>SECTION 15074</td>
<td>VIBRATION, SEISMIC &amp; WIND CONTROLS FOR HVAC PIPING</td>
<td>1 – 10</td>
</tr>
<tr>
<td>SECTION 15077</td>
<td>IDENTIFICATION FOR HVAC, PLUMBING &amp; FIRE PROTECTION PIPING &amp; EQUIPMENT</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 15085</td>
<td>PLUMBING PIPING INSULATION</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 15086</td>
<td>DUCT INSULATION</td>
<td>1 – 12</td>
</tr>
<tr>
<td>SECTION 15088</td>
<td>HVAC PIPING INSULATION</td>
<td>1 – 15</td>
</tr>
<tr>
<td>SECTION 15093</td>
<td>SLEEVES &amp; SLEEVE SEALS FOR PIPING</td>
<td>1 – 3</td>
</tr>
<tr>
<td>SECTION 15096</td>
<td>ESCUTCHEONS FOR PLUMBING, HVAC &amp; FIRE PROTECTION PIPING</td>
<td>1 – 2</td>
</tr>
<tr>
<td>SECTION 15111</td>
<td>GENERAL-DUTY VALVES FOR PLUMBING PIPING</td>
<td>1 – 6</td>
</tr>
<tr>
<td>SECTION 15112</td>
<td>GENERAL-DUTY VALVES FOR HVAC PIPING</td>
<td>1 – 7</td>
</tr>
<tr>
<td>SECTION 15140</td>
<td>DOMESTIC WATER PIPING</td>
<td>1 – 13</td>
</tr>
<tr>
<td>SECTION NO.</td>
<td>TITLE</td>
<td>PAGES</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>15145</td>
<td>DOMESTIC WATER PIPING SPECIALTIES</td>
<td>1 – 10</td>
</tr>
<tr>
<td>15150</td>
<td>SANITARY WASTE &amp; VENT PIPING</td>
<td>1 – 12</td>
</tr>
<tr>
<td>15155</td>
<td>SANITARY WASTE PIPING SPECIALTIES</td>
<td>1 – 8</td>
</tr>
<tr>
<td>15181</td>
<td>HYDRONIC PIPING</td>
<td>1 – 13</td>
</tr>
<tr>
<td>15195</td>
<td>FACILITY NATURAL-GAS PIPING</td>
<td>1 – 9</td>
</tr>
<tr>
<td>15216</td>
<td>GAS PIPING FOR LABORATORY &amp; HEALTHCARE FACILITIES</td>
<td>1 – 8</td>
</tr>
<tr>
<td>15732</td>
<td>PACKAGED, CHILLED WATER &amp; DX OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS</td>
<td>1 – 13</td>
</tr>
<tr>
<td>15815</td>
<td>METAL DUCTS</td>
<td>1 – 12</td>
</tr>
<tr>
<td>15820</td>
<td>DUCT ACCESSORIES</td>
<td>1 – 9</td>
</tr>
<tr>
<td>15840</td>
<td>AIR TERMINAL UNITS</td>
<td>1 – 7</td>
</tr>
<tr>
<td>15855</td>
<td>DIFFUSERS, REGISTERS &amp; GRILLES</td>
<td>1 – 3</td>
</tr>
<tr>
<td>15900</td>
<td>HVAC INSTRUMENTATION &amp; CONTROLS</td>
<td>1 – 14</td>
</tr>
<tr>
<td>15950</td>
<td>TESTING, ADJUSTING &amp; BALANCING</td>
<td>1 – 22</td>
</tr>
<tr>
<td>16050</td>
<td>REQUIREMENTS FOR ELECTRICAL INSTALLATIONS</td>
<td>1 – 4</td>
</tr>
<tr>
<td>16060</td>
<td>GROUNDING &amp; BONDING</td>
<td>1 – 7</td>
</tr>
<tr>
<td>16073</td>
<td>HANGERS &amp; SUPPORTS FOR ELECTRICAL SYSTEMS</td>
<td>1 – 7</td>
</tr>
<tr>
<td>16074</td>
<td>VIBRATION &amp; SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS</td>
<td>1 – 8</td>
</tr>
<tr>
<td>16075</td>
<td>ELECTRICAL IDENTIFICATION</td>
<td>1 – 10</td>
</tr>
<tr>
<td>16091</td>
<td>SLEEVES &amp; SLEEVE SEALS FOR ELECTRICAL RACEWAYS &amp; CABLELING</td>
<td>1 – 5</td>
</tr>
<tr>
<td>16120</td>
<td>CONDUCTORS &amp; CABLES</td>
<td>1 – 5</td>
</tr>
<tr>
<td>16124</td>
<td>MEDIUM VOLTAGE CABLES</td>
<td>1 – 7</td>
</tr>
<tr>
<td>16130</td>
<td>RACEWAYS &amp; BOXES</td>
<td>1 – 11</td>
</tr>
<tr>
<td>16140</td>
<td>WIRING DEVICES</td>
<td>1 – 8</td>
</tr>
<tr>
<td>16145</td>
<td>LIGHTING CONTROL DEVICES</td>
<td>1 – 7</td>
</tr>
<tr>
<td>16230</td>
<td>PACKAGED TRAILER MOUNTED ENGINE GENERATORS</td>
<td>1 – 11</td>
</tr>
<tr>
<td>16271</td>
<td>MEDIUM VOLTAGE TRANSFORMERS</td>
<td>1 – 8</td>
</tr>
<tr>
<td>16410</td>
<td>ENCLOSED SWITCHES &amp; CIRCUIT BREAKERS</td>
<td>1 – 4</td>
</tr>
<tr>
<td>16442</td>
<td>PANELBOARDS</td>
<td>1 – 12</td>
</tr>
<tr>
<td>16511</td>
<td>INTERIOR LIGHTING</td>
<td>1 – 12</td>
</tr>
<tr>
<td>16521</td>
<td>EXTERIOR LIGHTING</td>
<td>1 – 8</td>
</tr>
</tbody>
</table>

**APPENDIX**

| APN-01001 | PROJECT SCHEDULE – 17FEB12                                           | 1 – 1 |
| APN-01010 | FOUNDATION INVESTIGATION REPORT – 1MAR12                              | 1 – 32|
| APN-01715 | HAZARDOUS MATERIALS SURVEY – 8FEB12                                   | 1 – 7 |
END OF TABLE OF CONTENTS
DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01001 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

The University of Hawaii's SPECIAL PROVISIONS and GENERAL PROVISIONS following these specifications shall be read by the Contractor as they form a part of the agreement to be entered into between the Contractor and the University of Hawaii. These SPECIAL PROVISIONS and GENERAL PROVISIONS accompanying these specifications shall govern all work specified hereinafter in all Divisions and Sections.

1.02 DESCRIPTION OF BID PROPOSAL ITEMS

A. Basic Bid: As required by these Contract Documents and described in summary in SECTION 01010 – SUMMARY.

B. Additive Alternate (Upgrade Basic Bid Work) No. 1: As specified in SECTION 01100 – ADDITIVE BID ITEMS.

C. Unit Prices: As specified in SECTION 01151 – UNIT PRICES.

1.03 CONTRACT TIME

The contract time for this project shall be 130 consecutive calendar days from the effective date designated in the Notice to Proceed. From the effective date noted in the Notice to Proceed (NTP) letter, the Contractor shall proceed with his preparatory work such as: preparing and forwarding submittals, obtaining approvals, obtaining permits, and other work as approved by the University. No work shall be allowed at the job site and no ordering of materials shall be allowed until receipt of the Notice to Proceed letter, or upon earlier written notice from the University. The Contractor shall be responsible for any airfreight cost or overtime-cost differentials necessary to complete the project within the project contract time.

On-site construction time for this project shall be from 31 October 2012 to 1 May 2013.

1.04 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Request for substitutions shall be submitted within the time designated in the SPECIAL PROVISIONS.
B. Two copies of the written request shall be submitted together with Two (2) sets of technical brochures and be accompanied by Two (2) copies of a statement of variances as shown on the attached 'Sample Request for Substitution'. **Only "Request for Substitutions" using the attached sample format will be considered.** Electronic copy will be accepted.

The statement of variances must list all features of the proposed substitution, which differ from the plans; specifications and/or product(s) specified and must further certify that the substitute has no other variant features. The brochures shall be clearly marked showing make, model, size, options, etc., and must include sufficient evidence to enable the University to evaluate each feature listed as a variance. Any submittal with insufficient information for evaluation shall be rejected. Should an unlisted variance be discovered after installation of the product, the penalty shall be immediate replacement with the original specified product at no cost to the University.

If sufficient evidence from which a determination can be made for a particular model does not accompany a request for substitution, the request shall be denied. The decision of the University shall be final.

C. When submitting request for substitutions, if the Contractor elects to use materials and/or equipment other than those shown on plans and/or specifications, the Contractor shall be responsible to revise existing conditions and to coordinate work with other trades as may become necessary because of the substituted product. Any additional cost to implement such a change shall be borne by the Contractor at no cost to the University.

D. Bidders are cautioned to review the Technical Specifications carefully and thoroughly. Objections to or request for clarification of the specifications shall be made in writing and mailed to the Facilities and Environmental Health Office, 2327 Dole Street, Honolulu, Hawai‘i 96822, or delivered to 2010 East-West Road, UH Federal Credit Union Bldg. (rear entrance), Honolulu, Hawai‘i 96822 or Faxed to 956-0865 in accordance with the terms and conditions of this solicitation. The submittal of a bid shall be considered as acceptance of the specifications as published. Protest concerning the Technical Specifications lodged after bid opening shall not be considered.

1.05 **PATENTED DEVICES, MATERIALS AND PROCESSES**

If the Contractor is required or desires to use any design, device, material or process covered by letters of patent or copyright, the right for such use shall be procured by the Contractor from the patentee or owner. The Contractor and surety shall indemnify and hold harmless the State and its Departments and Agencies, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright in connection with the work to
be performed under the contract. The Contractor and surety shall indemnify the State and its Departments and Agencies for any costs, expenses and damages which it may be obliged to pay by reason of any such infringement at any time during the prosecution or after the completion of the work.

1.06 **GUARANTEE**

A. All work shall be guaranteed against all deficiencies in construction and materials for a minimum of one (1) year after the date of project acceptance. Longer guarantees may be required as specified within each section of the specifications.

B. The surety shall not be held liable beyond two (2) years of the Project Acceptance date.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**
SAMPLE

Date: __________________________

University of Hawai‘i Community Colleges
Facilities and Environmental Health Office
2327 Dole Street
Honolulu, Hawai‘i 96822
[Mailing Address]

OR

2010 East-West Road
UH Federal Credit Union Bldg. (Rear entrance)
Honolulu, Hawai‘i 96822
[Delivery Address]

Gentlemen:

Subject: REQUEST FOR SUBSTITUTION

Project Title: __________________________________________

In accordance with the GENERAL REQUIREMENTS, I hereby submit for substitution two (2) sets of technical brochures and statement of variances for your review and approval for the item(s) shown below.

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<thead>
<tr>
<th>SECTION/ITEM</th>
<th>SPECIFIED BRAND</th>
<th>SUBSTITUTE OR ALTERNATE BRAND FEATURES</th>
</tr>
</thead>
</table>

I further certify that my request for substitution of the above item(s) has no other variant features and complies with the plans and specifications for subject project.

_____________________________
SIGNATURE

NOTE: 1. Please use own letterhead.
2. Submit one (1) original and one (1) copy or electronic PDF copy.
3. If no variant feature indicate "None."

END OF SECTION

TECHNICAL SPECIFICATIONS
General Requirements

Project No. SW-12-6238
SECTION 01010 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

As specified in SECTION 01001 – GENERAL REQUIREMENTS.

1.02 SUMMARY OF PROJECT

A. The work to be done shall include performing all operations and furnishing all equipment, fixtures, appliances, tools, materials, and labor necessary to execute, complete, and deliver all of the work and related items required for the project as called for on the drawings and as hereinafter specified.

B. The project site is located on the University of Hawaii’s Windward Community College campus at 45-720 Kea’ahala Road, Kaneohe, Oahu, Hawaii, 96744.

C. Broad Scope Summary: The project shall in general consist of the addition of an approximately 1,969 square feet, new Vet Tech Facility on the northwest side of the Hale ‘Imiloa Building which houses the Natural Sciences Department. This facility will incorporate animal treatment, dog holding, cat holding, loading, storage, janitorial, radiology, darkroom and surgery functions. The work involves Structural, Architectural, Civil, Mechanical, Electrical, and Specialty Lab and Security work as indicated in the Contract Documents.

D. OFCI & OFOI Work: If any, as indicated on the Contract Drawings.

E. Hazardous Material Abatement: Hazardous Abatement is required as specified in SECTION 01715 – EXISTING CONDITIONS – HAZARDOUS MATERIALS SURVEY.


G. Contractor shall visit the job site and make certain that he understands the extent of the work and existing job conditions before he submits a formal bid.

H. Contact Mr. Clifford H. Togo, Vice Chancellor of Administrative Services, Windward Community College, telephone no. (808) 235-7403 to arrange for an appointment to visit the site. All questions pertaining to the plans and technical specifications shall be directed to the University’s Technical Representative.
1.03 CODES AND ORDINANCES

The Contractor shall comply with all Federal, State, and local laws, ordinances, rules, and regulations pertaining to the project and shall obtain and pay for all permits, licenses, and certificates and publish or post all notices required.

1.04 SCHEDULING AND COORDINATION

A. The premises will be occupied by the faculty, staff, and students of the University of Hawai‘i Community College.

B. Contractor shall submit schedule of work as called for in SECTION 01300 - SUBMITTALS. Work shall not commence until the Critical Path Method (CPM) schedule has been submitted and approved by the University. The Contractor shall be fully responsible for any delays caused by inadequate work schedules.

C. Community College Academic Calendar.

(See attached calendar at end of this section.)

No on-site work will be permitted during study period, examination period, and commencement.

D. Contractor shall schedule all utility, plumbing, and/or air conditioning outages on weekends unless directed by the University otherwise. All such outages shall be reflected in the schedule of work as called for in SECTION 01300 – SUBMITTALS and proper notice shall be served as called for in SECTION 01040 – COORDINATION.

Electrical outages will be permitted only on Saturdays, Sundays and holidays, and subject to approval by the University.

Air conditioning outages will be permitted on Saturdays, Sundays, and holidays, and subject to approval by the University.

The number of outages and duration of each outage shall be kept to a minimum.

1.05 SPECIFICATION LANGUAGE

These specifications are written in imperative and abbreviated form. This imperative language of the technical sections is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall", "the Contractor shall", and "shall be", and similar mandatory phrases by inference in the same manner as they are applied to notes on the drawings. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, perform all indicated requirements whether stated imperatively or otherwise. Wherever the word "Engineer", "Architect", or "Owner" is used, it means the "University".
1.06 DEFINITIONS

Definitions that govern this project are those specified in the GENERAL PROVISIONS of these contract documents. Additionally, the following words and terms used in these specifications are defined as follows:

A. Approved: As accepted by the University.

B. Approved Equal/Equivalent: (see definition of "Pre-Approved").

C. As applicable: As appropriate for the particular condition, situation, or circumstance.

D. As required: As required by regulatory requirements, by referenced standards, by existing conditions, by accepted construction practice, or by the contract documents.

E. Contractor: The prime contractor and/or any or all of its subcontractors as the context requires.

F. Directed: As instructed by the University in writing.

G. Indicated: As shown and/or noted on the drawings.

H. Job Site: (see definition of "Site").

I. Manufacturer: The manufacturer of a product and/or of the main components of group of related products comprising a functional system specified or proposed to be used on the project.

J. Owner: University of Hawaii and/or their authorized representatives.

K. Pre-Approved: As approved by the University in accordance with SECTION 01001 - GENERAL REQUIREMENTS, paragraph entitled "SUBSTITUTION OF MATERIALS AND EQUIPMENT".

L. Provide: Furnish and install.

M. Site/Site of the Work: The area to be occupied by the project(s) and all exterior areas occupied or used by the Contractor or his subcontractors during performance of the work, including storage areas, temporary buildings and staging areas.

N. Superintendent: The Contractor's representative who is responsible for continuous field supervision, coordination, and completion of the work.
O. **Technical Representative**: A person knowledgeable of all significant technical considerations relating to the design, specification, installation, functionality, longevity and warranty of a manufacturer's product or product system and authorized by the manufacturer to act in its behalf on all technical matters on the project including approval of plans and specifications, observation or installation and certification for warranty.

1.07 **PERMITS/FEES**

The Building Permit will be processed by the University for Contractor to pick up. The cost of building and all other permits and fees required for the construction and completion of the project shall be paid for by the Contractor.

1.08 **SAFETY**

A. The Contractor shall be responsible for complete compliance with Federal, State, and County safety laws and ordinances, and in particular with OSHA requirements with all latest amendments and supplements as applicable to this project.

B. The Contractor shall submit three (3) copies or electronic PDF copies of Material Safety Data Sheets (MSDS) on all chemical products to be used on the project for review and approval by the University's Environmental Health and Safety Office prior to their use. No chemical products shall be used without prior approval by the University.

1.09 **CONTRACTOR/SUBCONTRACTORS**

Contractor/Subcontractor shall be listed with the Department of Commerce & Consumer Affairs as being ACTIVE with the following STATUS: CURRENT, VALID & IN GOOD STANDING. Contractor/Subcontractor shall also be properly licensed, certified, and qualified by all other appropriate State and County agencies to perform their specific trade or particular type of work. At the time of bid opening, if the Contractor/Subcontractor is not in compliance with all of the above requirements, the Contractor/Subcontractor shall be considered “non-responsive” and shall be disqualified.

1.10 **CONTRACTOR RESPONSIBILITIES**

A. Responsibilities shall include general supervision, management, and control of the work of this project, and in addition to other items more specifically noted throughout the specifications.

B. **Superintendent/Staff**: The Contractor shall provide a competent superintendent on the job at all times during the progress of work with authority to act on behalf of the Contractor. The Contractor shall also provide an adequate staff to coordinate and expedite all work properly and orderly in compliance with the plans and specifications. In addition, all workers shall dress neatly and conduct themselves with propriety at all times; loud abusive behavior, sexual harassment, and unacceptable
conduct will not be tolerated. Workers found in violation of the above shall be removed from the job site as directed by the University.

C. **Existing Conditions:** Before commencing any work on this project, the Contractor shall verify if existing site and building conditions are the same as presented on the drawings and immediately report to the University any apparent discrepancies or inconsistencies.

D. **Shop Drawings:** Shop drawings, samples, color chips, schedules, catalogs, manufacturer’s literature, certificates, guarantees, bonds, as-built prints, and other items requiring University’s review or acceptance shall be submitted through the Contractor as part of the control of work. It is the Contractor’s responsibility to verify that all submitted items comply with the project’s plans and specifications prior to submitting to the University.

E. **As-Builts:** Contractor’s field superintendent is required to keep current one set of marked prints containing field changes made to or deviations taken from the construction documents during the construction period and shall enforce Subcontractors with the same requirements. See SECTION 01300 - SUBMITTALS paragraph entitled "RECORD DRAWINGS ("AS-BUILTS")".

F. **Laying Out Work**

1. **Bench Marks and Reference Points:** The Contractor shall establish bench marks and other reference points and keep them intact throughout the work of the project. The Contractor shall correctly locate all grades, lines, and levels as required for the construction and completion of the project; be solely responsible for the accuracy and correctness of all lines, levels, and grades; and for establishing the location of utilities at the site.

2. **Minor Changes:** Minor changes necessary to adjust conditions at the site to conform to the contract documents or vice versa will not be grounds for the Contractor to claim additional charges or additional time.

3. **Measurements:** Before ordering any material, or doing any work, each Contractor shall verify all measurements at the building and shall be responsible for the correctness of same. No extra charge or compensation will be allowed because of differences of actual dimensions and the measurements indicated on the drawings.

G. **Protection:** The Contractor shall be responsible for the protection and safeguarding of all new work until after final inspection and acceptance by the University. Whenever new concrete slabs, walks, etc., are a part of the project, the Contractor shall provide job site security for the first 24-hour period after each concrete pour.
PART 2 - PRODUCTS

2.01 ASBESTOS PROHIBITION

No asbestos containing materials or equipment shall be used in this section. The Contractor shall ensure that all materials and equipment incorporated in the project are asbestos-free.

2.02 QUALITY

Materials, equipment, furnishings, fixtures, hereinafter specified in the various divisions and sections of the specifications shall be new, best, commercial grade, class, kind, and type available.

2.03 HANDLING

The Contractor shall supervise job site delivery and handling, and assign storage space for materials, equipment, furnishings, and fixtures of all trades. Contractor is responsible for delivery, unloading, unpacking, handling, storage, distribution, installation, and protection of materials at the job site until acceptance by the University.

PART 3 - EXECUTION

3.01 INSTALLATION

Materials, equipment, furnishings, and fixtures hereinafter specified in the various divisions and sections of the specifications shall be installed in accordance with manufacturer's current specifications, recommendations, instructions, and directions by workers specially trained and skilled in the performance of the particular type of work, to meet guarantee and regulatory agency requirements specified.

3.02 ENVIRONMENTAL

Contractor shall oversee that proper environmental conditions are met regarding temperature, humidity, lighting, and ventilation.

3.03 PREPARATION AND PROTECTION

A. Before starting work on previously erected constructions, Contractor shall make a thorough and complete investigation of such recipient surfaces and determine their suitability to receive required additional construction and finishes. Contractor, at their own expense, shall make whatever repairs and conditioning required to properly prepare such surfaces. Contractor shall coordinate the work to provide suitable surfaces to receive subsequent work.
B. Commencement of work by any trade will be construed as acceptance of existing conditions and surfaces being satisfactory for application of subsequent work. Contractor shall be responsible for finished results and assumption of warranty obligations under the contract.

C. Contractor shall protect existing work in a manner to prevent any damage and take positive measures to prevent breakage of glass and damage to aluminum finishes.

D. Contractor shall exercise all required precautions necessary to protect all buildings and other construction on property adjacent to that of the work under the contract.

E. Prior to work affecting the interior of the building, the Contractor shall be responsible for covering door, window, hatch, louver, and similar openings in walls and overhead construction with plastic cloth or plywood to prevent interior work from damage by vandals or the elements. Contractor shall provide temporary lockable doors and temporary walls for complete protection of enclosed areas of the building. Throughout entire construction period, the Contractor shall provide adequate measures to fully protect all University property, students, staff, and public.

F. Contractor shall be responsible to trim any shrubbery, plants, and/or trees that may be affected by construction. Shrubbery and plants shall be trimmed twelve (12) inches or as required from the surfaces to be protected from damage. Tree trimming shall be to the minimum extent required to protect surfaces from damage. Contractor shall be responsible for having an arborist supervise all trimming of shrubbery, plants, and/or trees. Contractor shall notify the University fourteen (14) days prior to any scheduled trimming work as to the extent of work for approval.

3.04 CLEAN-UP

Rubbish and debris resulting from work of the various divisions and sections of the specifications shall be collected daily and disposed of by the Contractor in compliance with appropriate government laws. Contractor(s) or trade(s) specifically involved shall remove materials, debris, and rubbish from the site daily and dispose of at legal disposal areas away from the premises. Permission to provide on-site trash containers shall be granted by the University and shall be placed where directed by the University.
**UNIVERSITY OF HAWAI’I ACADEMIC CALENDAR 2011 – 2014**

<table>
<thead>
<tr>
<th>FALL SEMESTER</th>
<th>FALL 2011</th>
<th>FALL 2012</th>
<th>FALL 2013</th>
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<td>T Aug 14</td>
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<td>M-F Mar 25-29</td>
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| SUMMER SESSION I            | M May 21 – F June 29 | T May 28 – F Jul 5 | T May 27 – Th Jul 3 |
| SUMMER SESSION II           | M July 2 – F Aug 10 | M Jul 8 – Th Aug 15 | M Jul 7 – Th Aug 14 |

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1/ **Official Faculty Duty Date**: Reflects the official faculty duty dates for nine month faculty. “Beginning and ending dates for the duty period for each campus will be determined by the Employer, provided that the beginning date shall be between August 14th and September 14th and run for nine (9) consecutive months thereafter.” (UHPA Contract Agreement, 2003-2009)

2/ **First Day of Instruction**: “All campuses of the UH system shall adhere to a common first day of instruction each semester and observe holidays established by law.” (Board of Regents policy 5-5.c.)

3/ **Last Day of Instruction**: Reflects the minimum number of instructional days from the start date. Instruction shall end on or after this date.
4/ Study Period/Examination Period/Commencement: Campuses may set internal dates for study days, examinations, and commencement, but dates shall be no earlier than the “Last Day of Instruction.”

5/ Summer Session: Each campus schedules summer sessions according to individual campus objectives. Summer credit offerings must be equivalent to the fifteen week semester standard. (Board of Regents policy 5-5.c.) UHM Summer Session dates are included as a sample.

END OF SECTION
SECTION 01040 - COORDINATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

As specified in Section 01001.

1.02 COORDINATION REQUIREMENTS

A. Provide project interface and coordination as required to properly and accurately bring together the several parts, components, systems, and assemblies and as required to complete the work and the project, pursuant to the General Provisions. Contractor and Subcontractors shall cooperate with others engaged on the premises as may be necessary to facilitate progress and to provide coordination and integration of the entire work.

B. Provide interface and coordination of all trades, crafts, and subcontracts as required to provide correct and accurate connection of abutting, adjoining, overlapping, and related work, and provide all anchors, fasteners, accessories, appurtenances, and incidental items as required to complete the work properly, fully, and correctly in accordance with the Contract Documents.

C. Provide additional structural components, bracing, blocking, miscellaneous metal, backing, anchors, fasteners, and installation accessories required to properly anchor, fasten, or attach materials, equipment, hardware, systems and assemblies to the structure.

D. Provide excavation and backfill, trenching and drilling for all trades as required for the installation of their work.

E. Provide concrete foundations, pads, supports, bases, and grouting for all trades as required for the installation of their work.

F. Provide sealing, and flashing as required to waterproof the building complete and as required to insulate thermally and acoustically. Include sealing, flashing, and related work as required to prevent moisture intrusion, air infiltration, and light leakage.

G. Equipment, appliances, fixtures, hardware, and systems requiring plumbing and mechanical services, rough-in, and connections, or other utilities and services, shall be provided with such services, rough-in, and final connections.

H. Equipment, appliances, fixtures, hardware, and systems requiring electrical services shall be provided with such electrical services, including outlets, switches, overload protection, interlocks, panel board space, disconnects, circuit breakers, and connections.
I. Materials, equipment, component parts, accessories, incidental items, connections, and services required to complete the work which are not provided by subcontractors shall be provided by the Contractor.

1.03 WORK SEQUENCE

A. Construct work in stages to accommodate the University's occupancy requirements during the construction period. Work required of this contract to be performed in pedestrian and vehicular traffic areas or interfering with pedestrian and vehicular traffic flow shall be scheduled to minimize disturbances. Contractor shall confine all work, equipment, materials and personnel as much as possible within the Contract Zone Limits so as not to interfere with the normal function of the facility. Coordinate schedule and operations with University.

B. The facilities will be occupied and in use during the construction period. Therefore, the Contractor shall take every precaution to protect the students, staff, public and property from harm and/or damage. The Contractor shall schedule and coordinate his work and that of his Subcontractors to minimize disturbance to the University's daily operation.

C. The sequence of work shall be based on the CPM schedule approved by the University as called for in SECTION 01300 - SUBMITTALS.

1.04 CONTRACTOR USE OF PREMISES

A. Use of premises shall be limited to work and construction operations, to allow for University occupancy. Access to site shall be limited as directed by the University.

B. Parking: The Contractor will be allowed parking on campus in designated areas close to the work site subject to approval by the campus Vice Chancellor for Administrative Affairs/Services. Parking citations shall be issued to illegally parked vehicles whenever vehicles are parked outside or beyond the parking limits.

There are times the Contractor may be responsible for finding off-campus parking. Subject to approval by the University, striped stalls may be assigned and used for the project.

Any damage to property by construction vehicles shall be restored at no cost and to the satisfaction of the University. Construction vehicles will not be permitted to park in University employee parking areas or any striped parking stalls.

Private vehicles belonging to construction workers shall not be allowed to park on the University grounds. All company vehicles shall display company logos without exceptions.

1.05 CONTRACT ZONE LIMITS
The Contract Zone Limits shown on the drawings indicate only in general the limits of the work involved. The Contractor, however, is required to perform any and all necessary and incidental work which may fall outside of these demarcation lines. The Contractor is also expected to confine all of his construction activities within the Contract Zone limits and not to spread his equipment and materials indiscriminately about the area.

### 1.06 UNIVERSITY OCCUPANCY

University will occupy premises during entire period of construction for the conduct of normal operations. Cooperate with the University to minimize conflict, and to facilitate University's operations. Any interruption or interference caused by the Contractor which hampers the University's operations, shall be halted and re-scheduled to evenings and/or weekends at no additional cost to the University.

### 1.07 NOTICES

The Contractor shall schedule all temporary disconnection of electrical, air conditioning, and other utility services in such a manner so as to minimize such interruption to University operations. Interruptions shall be permitted only on Saturday, Sundays, and holidays. The Contractor shall request for outages in writing stating the proposed weekend for temporary disconnection, state the length of outage at least fifteen (15) days prior to outage and shall obtain the approval of the University prior to outage. Request for outage shall be submitted to the Architect or Engineer of the University of Hawaii Community College's Facilities and Environmental Health Office.

All such services, where necessary, shall be properly disconnected before commencing with the work.

### 1.08 PRE-AWARD SUBMITTAL(S) and MEETING(S)

The University may schedule a pre-award meeting to review the low bidder's bid and proposed methods of construction. As a special standard of responsibility and precondition of award, the low bidder shall: (1) within FIVE (5) calendar days of a request by the University, submit a detailed bid cost breakdown in a format acceptable to the University for its review; and (2) if a pre-award meeting is requested and scheduled by the University, the Contractor submitting the lowest reasonable and responsible bid, along with all subcontractors to be employed on the project, shall be required to attend. Failure to comply with either of the foregoing requirements shall be grounds for disqualifying one's bid for "lack of responsibility”.

### 1.09 PROJECT MEETINGS
University will schedule and administer all project meetings throughout the progress of the work including pre-construction meetings. University will make physical arrangements for meetings, prepare agenda, and preside at meetings. Those in attendance shall include: Job superintendent, major subcontractors and suppliers, Architect/Engineer and the University as appropriate to agenda topics for each meeting.

1.10 SUSPENSION OF WORK

University shall have the right to suspend work of the Contractor or its subcontractors whenever the University’s Facilities and Environmental Health Office determines that the Contractor’s or subcontractor’s practices (1) jeopardize health and safety or University property; (2) unreasonably disrupts University operations; and (3) are not in compliance with the plans and specifications herein. Only personnel of the University of Hawaii Community College’s Facilities and Environmental Health Office shall be authorized to order the suspension of work. Contractor shall not be entitled to any compensation for suspensions ordered by unauthorized personnel or for suspension due to the reasons stated herein.

1.11 FIELD MEASUREMENTS AND TEMPLATES

A. Contractor shall obtain all field measurements required for the accurate fabrication and installation of the work included in this contract. Exact measurements are the Contractor's responsibility.

B. Contractor shall also furnish or obtain templates, patterns, and setting instructions as required for the installation of all work. All dimensions shall be verified in the field.

1.12 CONTRACTOR’S RESPONSIBILITIES

A. The Contractor shall be in charge of this Contract and the site, as well as the directing and scheduling of all work.

It shall be the responsibility of the Contractor to provide the University’s Facilities and Environmental Health Office, with the following information on a daily basis or as agreed upon at the pre-construction meeting. Reports are due by 9:00 a.m.:

1. Status of project (location, phase of work, etc.).

2. A list of trades including the number of workmen and their title(s) present at the job site.

Note: No rain out or delay days will be granted the Contractor if Paragraph 1.12-A., Items 1 and 2 above are not complied with.
3. Digital photographs attached to daily log once every week. Comply with Division 1 – Photographic Documentation Section. Each photo shall include date, time, and reference work operations.

B. Final responsibility for performance, interface, and completion of the work and the project shall be the Contractor's.

C. After hour call back and/or emergency: The Contractor shall provide the University of Hawaii Community Colleges Facilities and Environmental Health Office, with a 24-hour emergency phone number where he can be contacted in the event of an emergency. The Contractor shall respond and take corrective action (within 4 hours) to calls made by the University regarding safety and/or hazardous situations directly related to their work. If the Contractor fails to respond or take proper corrective action, they shall be responsible for all costs incurred by the University.

D. Penalties for Utility and/or Air Conditioning Outages

The work under this project may include utility and/or air conditioning outages which must occur within the time frames specified in SECTION 01010, SUMMARY OF WORK; SECTION 15000, GENERAL MECHANICAL REQUIREMENTS AND SECTION 16010, GENERAL ELECTRICAL REQUIREMENTS of the Technical Specifications, as applicable. Inasmuch as University operations will not permit outages to exceed the established time frames, Contractor shall be assessed liquidated damages in the amount of $500 per HOUR for each hour of delay. Damages hereunder shall be separate from any other liquidated damages which may be assessed under this contract and shall not be used to offset or mitigate the same.

1.13 JOB SITE ADMINISTRATION

Shall be the responsibility of the Contractor.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION
SECTION 01100 – ADDITIVE BID ITEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

As specified in SECTION 01001 – GENERAL REQUIREMENTS.

1.02 REQUIREMENTS INCLUDED

A. This section identified each additive bid item by number, and describes the basic changes to be incorporated into the work, only when that additive bid item is made a part of the work by specific provisions in the University-Contractor Agreement.

B. In order that an award may be made within the funds allocated for this project, each bidder must enter in his bid, a bid for each and every additive bid item herein listed, stating the amount to be deducted from and/or added to his lump sum basic bid in each case. The University reserves the right to accept or reject any one or all of the additive bid item bids.

C. The description of additive bid items is not intended to give a detailed description of all additional work required by addition of an additive bid item, as only the principal features of such additional work are listed.

D. Should any one or all of the additive bid items become a part of the contract, the cost of all additional work required by the addition of the additive bid item, even though not specifically mentioned herein shall be included in the bid for each specific additive bid item.

1.03 DESCRIPTION OF ADDITIVE BID ITEMS

A. Additive Bid Item #1:


2. Additive Bid Item: In lieu of Base Contract paint coating systems, submit added lump sum cost to finish all interior substrates with epoxy paint systems as specified under “Interior Paint Schedule – Specialty Coatings” as specified in Division 9 – Paints & Coatings Section.

B. Additive Bid Item #2:

1. Base Bid: Not in Base Bid.
2. **Additive Bid Item:** Provide trailer mounted standby generator as specified in Division 16 – Packaged Trailer Mounted Engine Generators Section.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

END OF SECTION
SECTION 01151 – UNIT PRICES

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS
As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Administrative and procedural requirements for unit prices.

B. Related Sections:
   1. Division 1 Sections.
   2. When specified for each Unit Price.

1.03 DEFINITIONS:
A. Unit Price: An amount proposed by Bidders, stated on the Bid Form, as a price per unit of measurement for materials or services added to or deducted from the Contract Sum in accordance with Contract modification procedures. Each unit price to be a complete cost for all necessary materials, delivery, installation, insurance, applicable taxes, overhead, and profit.

1.04 SUBMITTALS:
A. General: For any work covered by a Unit Price in which specified requirements are not specified in other Sections, submit Product Data, Shop Drawings, Samples, and other data needed by University to determine scope of the Work to be provided.

1.05 QUALITY ASSURANCE:
A. Prior to Signing Contract for the Work: Meet with the University to review scope, procedures, and materials to be provided for Unit Price Work; in order to avoid potential misunderstandings after the Contract is awarded.

B. Measurement and Payment: Verify Bid Form list with list of unit prices stated herein. Where differences occur, notify University and secure clarification of requirements.
C. **University’s Right:** The University reserves the right to reject Contractor’s measurement of work-in-place that involves use of established unit prices and to have this work measured, at the University’s expense, by an independent surveyor acceptable to Contractor.

**PART 2 – PRODUCTS**

(Not Used)

**PART 3 – EXECUTION**

3.01 **BIDDING PROCEDURE:**

A. **Bid Form:** Submit a price for all Unit Prices required.

B. **Qualifications:** Submit a price based upon the indicated measurement and unit price required, however, if a clarification is required as to what will be provided, prices may be qualified with understanding that such qualifications may have an impact on acceptance of the Bid, when qualification reduces the scope and/or quality of work to be provided in any way; as each requested unit price is inclusive of all work necessary to accomplish the requested each unit price under all conditions to be encountered for the Work.

C. **Quantities:** Where specific quantities are indicated, these are to be interpreted as a potential minimums and Contractor shall by Site investigation, determine the actual amount of work needed for each unit price requested. Notify University in timely manner when quantities cannot be reasonably determined during Bidding. No request for additional costs will be considered after Bids are submitted.

3.02 **SCHEDULE OF UNITS PRICES:**

A. **Unit Price A:**

1. **For:** MVT-1 as specified in SECTION 09610 – FLOORING TREATMENT when moisture vapor transmission exceeds 3 lbs / 1000 sf / 24 hrs but is not greater than 14 lbs / 1000 sf / 24 hrs or when pH level exceeds 9 or when both occurs.

2. **Cost Basis:** Cost per square feet based on entire area covered with each floor finish for which MVT membrane is required.

B. **Unit Price B:**
1. **For:** MVT-2 as specified in SECTION 09610 – FLOORING TREATMENT when moisture vapor transmission exceeds 3 lbs / 1000 sf / 24 hrs but is not greater than 25 lbs / 1000 sf / 24 hr or when pH level exceeds 9 or when both occurs.

2. **Cost Basis:** Cost per square feet based on entire area covered with each floor finish for which MVT membrane is required.
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

As specified in SECTION 01001-GENERAL REQUIREMENTS.

1.02 PROCEDURES

A. Unless otherwise specified, deliver submittals to the UH Community Colleges Facilities and Environmental Health, 2010 East-West Road, Credit Union Building (rear entrance), Honolulu, Hawaii 96822 or mail to 2327 Dole Street, Honolulu, HI 96822.

B. Transmit all items using form which identifies project, Contractor, Subcontractor, and major supplier. Identify pertinent drawing sheet, detail number, and specification section number, as appropriate. Identify deviations from contract documents. Provide space for Architect/Engineer review stamps.

C. All submittals shall consist of a minimum of four (4) copies or electronic PDF copy.

D. Comply with the Schedule of Operations in making submittals. Coordinate submittals of related work.

E. After the University's review of the submittals, revise and resubmit as required, identifying changes made since previous submittal.

1.03 SCHEDULE OF WORK

Contractor shall submit schedule of work within two (2) weeks from the effective date noted in the "Notice to Proceed" letter, identifying first workday of each week. Show complete sequence of construction by activity, identifying work of separate stages and other logically grouped activities. Show submittal dates required for shop drawings, product data, samples and product delivery dates. The Schedule of Work shall follow the Critical Path Method (CPM) and shall be updated on a regular basis to include all changes. Project shall not commence until the CPM schedule is submitted and approved. No claims for extension shall be granted if the CPM schedule is not submitted. Also, submit a three week schedule of work indicating areas, floors and rooms to be worked on and the various trades or type of work to be undertaken daily, Monday through Friday. Three-week work schedule shall be updated every week.

1.04 SUBMITTAL LIST

Contractor shall submit all submittals as listed on the Submittal List included under this section.
1.05 SHOP DRAWINGS AND SAMPLE SUBMITTALS

A. All submittals shall be made in accordance with the following unless otherwise specified. Minimum sheet size is 8-1/2” x 11”. Maximum sheet size is same size as the Contract Drawings. Drawings shall be presented in a clear and thorough manner. Details shall be identified by reference to sheet, schedule, and detail shown on Contract Drawings.

B. Mark each copy to identify applicable products, models and other data. Supplement manufacturers’ standard data to provide information unique to the work. Include manufacturers’ installation instructions when required by the specification.

1. The Contractor shall review, stamp with his approval and submit with reasonable promptness and in orderly sequence so as to cause no delay in work of any other Subcontractor, all shop drawings, product data, and samples required by the Contract Documents or subsequently by the University as covered by the modifications.

2. Properly identify shop drawings and samples as specified, or as the University may require. At the time of submission, the Contractor shall inform the University in writing of any deviation in the shop drawings or samples from requirements of the Contract Documents.

3. By approving and submitting the shop drawings and samples, the Contractor thereby represents that he has determined and verified all field measurements, field criteria, materials, catalog numbers and similar data, or will do so, and that he has checked and coordinated each shop drawing and sample with the requirements of the Contract Documents.

4. Six (6) copies of the Shop Drawings shall be submitted for review.

5. When requested by the University, the Architect (and/or his Consultant) will review the shop drawings and samples with reasonable promptness so as to cause no delay but only for conformance with the design concept of the Project and with the information given in the Contract Documents. The Architect's (and/or his Consultant's) review of a separate item shall not indicate approval of an assembly in which the item functions.

6. The Contractor shall make any corrections required by the University and shall resubmit the required number of corrected copies of shop drawings or new samples for review. The Contractor shall direct specific attention in writing or on resubmitted shop drawings to revisions other that the corrections requested by the University on previous submissions.
7. The Architect's (and/or Consultant's) review of shop drawings or samples shall not relieve the Contractor of responsibilities for any deviation from the requirements of the Contract Documents unless the Contractor has informed the University in writing of such deviation, at time of submission, and the University has given written approval to the specific deviation; nor shall the Architect's (and/or his Consultant's) review relieve the Contractor from responsibility for errors or omissions in the shop drawings or samples.

8. No portion of the work requiring a shop drawing or sample submission shall be commenced until the submission has been reviewed by the University. All such portions of the work shall be in accordance with reviewed shop drawings and samples.

C. Samples: Submit full range of manufacturers' standard textures, colors, and patterns for the University's selection. Submit samples as specified in the respective Specifications sections and as noted above. Samples shall illustrate functional characteristics of the Product, with integral parts and attachment devices. Coordinate submittal of different categories for interfacing work. Include identification on each sample, giving full information.

1.06 MANUFACTURERS' CERTIFICATES

Submit certificates, warranties, operating and maintenance instructions in accordance with requirements of each specifications section. Submit in duplicate.

1.07 RECORD DRAWINGS ("AS BUILTS")

A. The Contractor shall provide Record Drawings, as follows: Provide and keep current a complete set of record drawings showing every architectural, structural, plumbing, fire protection, mechanical, and electrical change from the original Contract Documents, including all addenda, change order, job decision, etc. The intent of Record Drawings is to record the actual in-place construction so that any future renovations or tie-ins can be anticipated accurately.

B. All changes authorized by the University and recorded by the Contractor under SECTION 01010 – SUMMARY OF WORK.

C. All deviations, changes, invert, location, etc., from alignment, elevations and dimensions which are stipulated on the Drawings and Shop Drawings, Specifications, addendum(a) and modification(s) during construction of the work shall be recorded on the Record Drawings.
D. The following procedure shall be followed:

1. Immediately after these changes are constructed in place, the Contractor shall record them on the field office plans. This is to assure that changes are recorded before they are forgotten.

2. Plans shall also record the location of all concealed water and electric services, water piping, sewers, wastes, vents, ducts, conduit and other piping; by indication of measured dimensions to each such line from readily identifiable and accessible walls, columns, partitions, or corners of the buildings.

3. Within two weeks after final inspection of the project, the Architect/Engineer shall transfer the changes marked on the field office plans onto the reproducible tracings. Any deletions shall be eradicated from the tracings and redrawn as necessary. The Contractor shall stamp or mark the tracings "AS-BUILT," and also sign and date each drawing so marked.

4. The Contractor shall submit the record drawings together with the marked-up field office plans to the University.

5. Any record drawings or field office plans which the University determines does not accurately record the deviation shall be corrected by the Contractor and resubmitted to the University.

1.08 SUBMITTAL LIST FORM

See following page.
SUBMITTALS LIST

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DIVISION 1 – GENERAL REQUIREMENTS</td>
</tr>
<tr>
<td>1</td>
<td>01001 – GENERAL REQUIREMENTS</td>
</tr>
<tr>
<td>2</td>
<td>01010 – SUMMARY OF WORK</td>
</tr>
<tr>
<td>4</td>
<td>01040 – COORDINATION</td>
</tr>
<tr>
<td>5</td>
<td>01100 – ADDITIVE BID ITEMS</td>
</tr>
<tr>
<td>6</td>
<td>01151 – UNIT PRICES</td>
</tr>
<tr>
<td>7</td>
<td>01300 – SUBMITTALS</td>
</tr>
<tr>
<td>8</td>
<td>01323 – PHOTOGRAPHIC DOCUMENTATION</td>
</tr>
<tr>
<td>9</td>
<td>01400 – QUALITY CONTROL</td>
</tr>
<tr>
<td>10</td>
<td>01500 – CONSTRUCTION FACILITIES</td>
</tr>
<tr>
<td>11</td>
<td>01567 – POLLUTION CONTROL</td>
</tr>
<tr>
<td>12</td>
<td>01600 – PRODUCT REQUIREMENTS - GENERAL</td>
</tr>
<tr>
<td>13</td>
<td>01610 – PRODUCT REQUIREMENTS - FASTENERS &amp; ANCHORS</td>
</tr>
<tr>
<td>14</td>
<td>01700 – CONTRACT CLOSEOUT</td>
</tr>
<tr>
<td>15</td>
<td>01715 – EXISTING CONDITIONS – HAZARDOUS MATERIALS SURVEY</td>
</tr>
<tr>
<td>16</td>
<td>01735 – CUTTING &amp; PATCHING</td>
</tr>
<tr>
<td>17</td>
<td>01740 – CLEANING</td>
</tr>
<tr>
<td></td>
<td>DIVISION 2 – SITE CONSTRUCTION</td>
</tr>
<tr>
<td>18</td>
<td>02220 – SITE DEMOLITION</td>
</tr>
<tr>
<td>19</td>
<td>02363 – TERMITE CONTROL – SS SCREEN BARRIER SYSTEMS</td>
</tr>
<tr>
<td></td>
<td>DIVISION 3 – CONCRETE</td>
</tr>
<tr>
<td>20</td>
<td>03100 – CONCRETE FORMWORK</td>
</tr>
<tr>
<td>21</td>
<td>03150 – CONCRETE ACCESSORIES</td>
</tr>
<tr>
<td>22</td>
<td>03200 – CONCRETE REINFORCEMENT</td>
</tr>
<tr>
<td>23</td>
<td>03300 – CAST-IN-PLACE CONCRETE</td>
</tr>
<tr>
<td>24</td>
<td>03350 – CONCRETE FINISHING</td>
</tr>
<tr>
<td>25</td>
<td>03480 – PRECAST CONCRETE SPECIALTIES</td>
</tr>
<tr>
<td>26</td>
<td>03700 – CONCRETE REPAIR</td>
</tr>
</tbody>
</table>

TECHNICAL SPECIFICATIONS
Table of Contents
Project No. SW-12-6238
01300-5
<table>
<thead>
<tr>
<th>Division</th>
<th>Project No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIVISION 4 – MASONRY</td>
<td>04220 – CONCRETE MASONRY UNITS</td>
<td>X X X X X</td>
</tr>
<tr>
<td>DIVISION 5 – METALS</td>
<td>05080 – SHOP-APPLIED FINISHES FOR METAL</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>05120 – STRUCTURAL STEEL</td>
<td>X X X X X</td>
</tr>
<tr>
<td></td>
<td>05300 – STEEL DECK</td>
<td>X X X X X</td>
</tr>
<tr>
<td></td>
<td>05400 – COLD-FORMED METAL FRAMING</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>05500 – METAL FABRICATIONS – COMMON WORK RESULTS</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>05501 – METAL FABRICATIONS – STEEL</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>05503 – METAL FABRICATIONS – STAINLESS STEEL</td>
<td>X X</td>
</tr>
<tr>
<td>DIVISION 6 – WOOD &amp; PLASTICS</td>
<td>06070 – WOOD TREATMENT</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>06100 – ROUGH CARPENTRY</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>06640 – PLASTIC PANELING</td>
<td>X X</td>
</tr>
<tr>
<td>DIVISION 7 – THERMAL &amp; MOISTURE PROTECTION</td>
<td>07051 – MOISTURE PROTECTION – COMMON WORK RESULTS</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>07190 – WATER REPELLENTS</td>
<td>X X X X</td>
</tr>
<tr>
<td></td>
<td>07210 – BUILDING INSULATION</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>07220 – ROOF &amp; DECK INSULATION</td>
<td>X X X X X</td>
</tr>
<tr>
<td></td>
<td>07240 – EXTERIOR &amp; INSULATION &amp; FINISH SYSTEMS</td>
<td>X X X X</td>
</tr>
<tr>
<td></td>
<td>07262 – VAPOR RETARDERS – BELOW GRADE</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>07550 – MODIFIED BITUMINOUS MEMBRANE ROOFING</td>
<td>X X X X</td>
</tr>
<tr>
<td></td>
<td>07600 – FLASHING &amp; SHEET METAL</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>07900 – JOINT SEALERS</td>
<td>X X X X</td>
</tr>
<tr>
<td>DIVISION 8 – DOORS &amp; WINDOWS</td>
<td>08110 – HOLLOW METAL DOORS &amp; FRAMES</td>
<td>X X X X</td>
</tr>
<tr>
<td></td>
<td>08700 – HARDWARE</td>
<td>X X X X</td>
</tr>
<tr>
<td></td>
<td>08712 – ELECTRONIC ACCESS CONTROL</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>08800 – GLAZING</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>08995 – GLAZED METAL FRAMING SYSTEMS</td>
<td>X X X X</td>
</tr>
<tr>
<td>DIVISION 9 – FINISHES</td>
<td>09100 – METAL SUPPORT ASSEMBLIES</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>09250 – GYPSUM BOARD</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>09510 – ACOUSTICAL CEILINGS</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>09610 – FLOORING TREATMENT</td>
<td>X X X X X</td>
</tr>
<tr>
<td></td>
<td>09650 – RESILIENT FLOORING</td>
<td>X X X X X</td>
</tr>
<tr>
<td></td>
<td>09675 – SEAMLESS EPOXY-QUARTZ FLOORING</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>09900 – PAINTS &amp; COATINGS</td>
<td>X X X</td>
</tr>
<tr>
<td>DIVISION 10 – SPECIALTIES</td>
<td>10220 – LOUVERED EQUIPMENT ENCLOSURES</td>
<td>X X X X</td>
</tr>
<tr>
<td></td>
<td>10260 – WALL &amp; CORNER GUARDS</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>10400 – IDENTIFYING DEVICES</td>
<td>X X</td>
</tr>
<tr>
<td>DIVISION 11 – EQUIPMENT</td>
<td>11601 – LABORATORY EQUIPMENT</td>
<td>X X X X</td>
</tr>
<tr>
<td>DIVISION 12 – FURNISHINGS</td>
<td>12350 – SPECIALTY CASEWORK</td>
<td>X X X</td>
</tr>
<tr>
<td>DIVISION 13 – SPECIAL CONSTRUCTION</td>
<td>13185 – KENNELS &amp; ANIMAL SHELTERS</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>13282 – LEAD-CONTAINING PAINT</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>66</td>
<td>13930 – WET-PIPE FIRE-SUPPRESSION SPRINKLERS</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>DIVISION 14 – CONVEYING SYSTEMS (NOT USED)</strong></td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>15082 – HANGERS &amp; SUPPORTS PIPING &amp; EQUIPMENT</td>
<td>X</td>
</tr>
<tr>
<td>68</td>
<td>15072 – VIBRATION &amp; SEISMIC CONTROLS FOR FIRE SUPPRESSION PIPING &amp; EQUIPMENT</td>
<td>X</td>
</tr>
<tr>
<td>69</td>
<td>15074 – VIBRATION, SEISMIC &amp; WIND CONTROLS FOR HVAC PIPING, DUCT &amp; EQUIPMENT</td>
<td>X</td>
</tr>
<tr>
<td>70</td>
<td>15077 – IDENTIFICATION FOR HVAC, PLUMBING &amp; FIRE PROTECTION PIPING &amp; EQUIPMENT</td>
<td>X</td>
</tr>
<tr>
<td>71</td>
<td>15085 – PLUMBING PIPING INSULATION</td>
<td>X</td>
</tr>
<tr>
<td>72</td>
<td>15086 – DUCT INSULATION</td>
<td>X</td>
</tr>
<tr>
<td>73</td>
<td>15088 – HVAC PIPING INSULATION</td>
<td>X</td>
</tr>
<tr>
<td>74</td>
<td>15093 – SLEEVES &amp; SLEEVE SEALS FOR PIPING</td>
<td>X</td>
</tr>
<tr>
<td>75</td>
<td>15096 – ESCUTCHEONS FOR PLUMBING, HVAC &amp; FIRE PROTECTION PIPING</td>
<td>X</td>
</tr>
<tr>
<td>76</td>
<td>15111 – GENERAL-DUTY VALVES FOR PLUMBING PIPING</td>
<td>X</td>
</tr>
<tr>
<td>77</td>
<td>15112 – GENERAL-DUTY VALVES FOR HVAC PIPING</td>
<td>X</td>
</tr>
<tr>
<td>78</td>
<td>15140 – DOMESTIC WATER PIPING</td>
<td>X</td>
</tr>
<tr>
<td>79</td>
<td>15145 – DOMESTIC WATER PIPING SPECIALTIES</td>
<td>X</td>
</tr>
<tr>
<td>80</td>
<td>15150 – SANITARY WASTE &amp; VENT PIPING</td>
<td>X</td>
</tr>
<tr>
<td>81</td>
<td>15155 – SANITARY WASTE PIPING SPECIALTIES</td>
<td>X</td>
</tr>
<tr>
<td>82</td>
<td>15181 – HYDRONIC PIPING</td>
<td>X</td>
</tr>
<tr>
<td>83</td>
<td>15195 – FACILITY NATURAL-GAS PIPING</td>
<td>X</td>
</tr>
<tr>
<td>84</td>
<td>15216 – GAS PIPING FOR LABORATORY &amp; HEALTHCARE FACILITIES</td>
<td>X</td>
</tr>
<tr>
<td>85</td>
<td>15732 – PACKAGED, CHILLED WATER &amp; DX OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS</td>
<td>X</td>
</tr>
<tr>
<td>86</td>
<td>15815 – METAL DUCTS</td>
<td>X</td>
</tr>
<tr>
<td>87</td>
<td>15820 – DUCT ACCESSORIES</td>
<td>X</td>
</tr>
<tr>
<td>88</td>
<td>15840 – AIR TERMINAL UNITS</td>
<td>X</td>
</tr>
<tr>
<td>89</td>
<td>15855 – DIFFUSERS, REGISTERS &amp; GRILLES</td>
<td>X</td>
</tr>
<tr>
<td>90</td>
<td>15900 – HVAC INSTRUMENTATION &amp; CONTROLS</td>
<td>X</td>
</tr>
<tr>
<td>91</td>
<td>15950 – TESTING, ADJUSTING &amp; BALANCING</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>DIVISION 16 – ELECTRICAL</strong></td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>16050 – REQUIREMENTS FOR ELECTRICAL INSTALLATIONS</td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>16060 – GROUNDING &amp; BONDING</td>
<td>X</td>
</tr>
<tr>
<td>94</td>
<td>16073 – HANGERS &amp; SUPPORTS FOR ELECTRICAL SYSTEMS</td>
<td>X</td>
</tr>
<tr>
<td>95</td>
<td>16074 – VIBRATION &amp; SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>16075 – ELECTRICAL IDENTIFICATION</td>
<td>X</td>
</tr>
<tr>
<td>97</td>
<td>16091 – SLEEVES &amp; SLEEVE SEALS FOR ELECTRICAL RACEWAYS &amp; CABLING</td>
<td>X</td>
</tr>
<tr>
<td>98</td>
<td>16120 – CONDUCTORS &amp; CABLES</td>
<td>X</td>
</tr>
<tr>
<td>99</td>
<td>16124 – MEDIUM VOLTAGE CABLES</td>
<td>X</td>
</tr>
<tr>
<td>100</td>
<td>16130 – RACEWAYS &amp; BOXES</td>
<td>X</td>
</tr>
<tr>
<td>101</td>
<td>16140 – WIRING DEVICES</td>
<td>X</td>
</tr>
<tr>
<td>102</td>
<td>16145 – LIGHTING CONTROL DEVICES</td>
<td>X</td>
</tr>
<tr>
<td>103</td>
<td>16230 – PACKAGED TRAILER MOUNTED ENGINE GENERATORS</td>
<td>X</td>
</tr>
<tr>
<td>104</td>
<td>16271 – MEDIUM VOLTAGE TRANSFORMERS</td>
<td>X</td>
</tr>
<tr>
<td>105</td>
<td>16410 – ENCLOSED SWITCHES &amp; CIRCUIT BREAKERS</td>
<td>X</td>
</tr>
<tr>
<td>Page</td>
<td>Document Description</td>
<td>Xs</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>106</td>
<td>16442 – PANELBOARDS</td>
<td>X X X X</td>
</tr>
<tr>
<td>107</td>
<td>16511 – INTERIOR LIGHTING</td>
<td>X X X X</td>
</tr>
<tr>
<td>108</td>
<td>16521 – EXTERIOR LIGHTING</td>
<td>X X X X</td>
</tr>
<tr>
<td>109</td>
<td>APN-01001 – PROJECT SCHEDULE – 17FEB12</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>APN-01010 – FOUNDATION INVESTIGATION REPORT – 1MAR12</td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>APN-01715 – HAZARDOUS MATERIALS SURVEY – 8FEB12</td>
<td></td>
</tr>
</tbody>
</table>

END OF TABLE OF CONTENTS
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.01 SUMMARY:
   A. Section Includes:
      1. Digital color construction photographs.
   B. Related Sections:
      1. Division 1 Sections.
      2. All work.

1.02 DEFINITIONS:
   A. Intent for Number of Photos: The number of photographs will vary and may not be required or exceed the base line maximum specified at any given time; as may be necessary to achieve photographing intent. The general intent is to compile a historical sequence and record of ongoing construction of each primary Project system or product being installed and to show concealed services that can assist the Owner in any future addition, renovation, an ongoing maintenance of his Project. Contractor, Owner and Architect to arrive at a general understanding of desired kinds and number of photos to be taken.
   B. Aerial Photographs: Photographs taken from an airplane.
   C. Non-Aerial Photographs: Photographs not taken from an airplane. This definition does exclude aerial photographs taken from other available vantage points, including the following.
      1. Accessible higher locations from adjacent buildings or other higher elevated geographical features, e.g. mountains and hills.
      2. Available Contractor’s on-Site equipment designed for lifting persons to higher elevations, e.g. boom lifts, man lifts, scissor lifts and cranes.

1.03 SUBMITTALS:
   A. Photographs: Submit photographs as follows.
      1. Weekly Submittals:
a. **Type**: Non-aerial (by airplane) construction photographs.

b. **Number of Photos**: Up to 10 – 50 photos per week.

c. **Submittals**: Submit two (2) sets of following.

   1) **Electronic Data**: Record each data to recording media with identifying name and date.

   2) **Plan Drawings**: Show locations of what is shown on each photograph.

d. **When Submittals Required**: Submit at end of each work week attached to Weekly Activity Schedules as specified in Division 1 – Coordination Section.

2. **Closeout Submittals**: Submit following.

   a. **Electronic Data**: Record and compile selected Architect and Owner photos; selected from all photos taken during duration of Project as part of Closeout submittals. Record in historical sequence and as otherwise directed by Architect.

   b. **Hardcopies**: Include hardcopy printouts on photographic paper as part of Owner’s Closeout Project Manual.

   c. **Drawings**: Plans showing locations of what is shown on each photo.

1.04 **QUALITY ASSURANCE**:

A. **Photographer**: Contractor to assign dedicated personnel to take photographs on regular basis and to work with Architect in properly documenting progress and details of installed work. Personnel to have photographing experience, proper knowledge of camera usage, and requisite understanding of construction.

B. **Camera Type**: High resolution digital camera producing photographs acceptable to Architect. Resolution of camera to be highest or very close to highest commercial (not necessarily Professional) resolution available at time Project is started. Digital camera to be capable of placing date and time minimum on each photo.

C. **Recording Media**: Record data to most current technology, e.g., DVD-R disks, or other Architect acceptable recordable media that is viewable on current Owner’s computer and that which produces the current best quality images available to the general (not professional) public, unless a professional grade media is specified.
D. **Photographic Documentation**: Each photograph, whether hardcopy or electronic, to be identified with following.

1. Date and time.
2. Summary text describing what photograph is about.
3. Summary text describing where photograph taken.
4. Other identifying text as required to readily identify it on other related documentation, e.g. drawings.

E. **Non-Aerial Photographs – Special Conditions**:

1. **Photo Vantage Points**: Do not use any photographic vantage point that would pose a danger to those taking the photographs at any time. Secure the University’s acceptance where access to non-public vantage points are desired, e.g. roofs of adjacent buildings.

2. **Available Lifting Equipment**: If the Contractor requires a person(s) lifting equipment for this Project and such equipment is on-Site, secure photographs as needed to comply with this Section during each time such equipment is on-Site and when such equipment offers a photographing advantage.

PART 2 - PRODUCTS  (Not Used)

PART 3 - EXECUTION

3.01 **EXECUTION**:

A. **General**: Owner’s Agent to continually work with assigned Contractor’s personnel to work out general types of photographs to be taken.

B. **Intent – Aerial Photographs**: Not required.

C. **Intent – Non-Aerial Construction Photographs – Types of Work Photographed**:

1. “Before” photographs of existing work; including those that may be damaged as a result of Contractor’s operations.

2. Photos from distance of Site and each Project work.

3. Close-up photos of each installed work to show compliance with Contract requirements.
4. Closeup and distant photos of concealed services in detail as necessary to assist Owner in locating each work; whether below grade and in each structure for future addition, renovation and maintenance.

5. Photos of all critical details of all work.

6. Distance and close-up photos of non-complying work, if any.

7. Photos of any cutting and patching and restoration work, if any.

8. Photos documenting Contractor procedures for accomplishing each work.

9. Other as may be determined by Architect during course of the Work.

D. Intent – Non-Aerial Construction Photographs – Photographic Vantage Points: Photographs to be taken from following vantage points as most advantageous to each work being photographed.

1. From available at grade locations and at grade built structures around the Site.

2. From adjacent at grade locations on University grounds outside the Project Contract Limits.

3. From accessible adjacent University buildings, including roofs; when required and acceptable to the University.

END OF SECTION
SECTION 01400 - QUALITY CONTROL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

As specified in SECTION 01001 – GENERAL REQUIREMENTS.

1.02 APPLICABLE CODES AND STANDARDS

A. All work shall meet or exceed the requirements of the Uniform Building Code (UBC), International Building Code (IBC), Uniform Plumbing Code (UPC), National Electrical Code (NEC), latest adopted editions and the applicable codes and ordinances having jurisdiction of the County, State, and Federal governments.

B. References in the specifications to "code" or to "building code" not otherwise identified, shall mean the foregoing specified codes, together with the additions, changes, amendments, and interpretations adopted by the enforcing agency, and in effect on the date of these contract documents. Nothing on the drawings or in the specifications shall be interpreted as requiring or permitting work that is contrary to these rules, regulations, and codes. Any such discrepancies shall be brought to the attention of the University immediately.

C. Where other codes or standards are referenced hereinafter in these specifications, the affected work shall meet or exceed the applicable requirements of such codes and standards. When latest edition of a standard is specified, it shall mean the latest edition in effect as of the date of these contract documents. When the documents are not dated, the date of execution of the agreement shall establish the date of the contract documents.

D. The code, specification, or standard referred to shall have full force and effect as though printed in these specifications, except as modified in these specifications.

E. Where the drawings or specifications call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by said laws, codes, rules, and regulations, the provisions of the drawings and specifications shall take precedence over said laws, codes, rules, and regulations.

1.03 OTHER APPLICABLE LAWS AND REGULATIONS

All applicable Federal, State, and local laws, and the regulations of governing utility districts and the various other authorities having jurisdiction over the construction and completion of the project shall apply to the contract throughout,
and they shall be deemed to be included in the contract the same as though printed in the specifications.

1.04 REFERENCES

A. The contract documents contain references to various standard specifications, codes, practices, and requirements for materials, work quality, installation, inspections, and tests, which references are published and issued by the organizations, societies, and associations listed below by abbreviation and name. Such references are hereby made a part of the contract documents to the extent required.

B. Referenced specifications and standards of the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI), are identified in the various sections by abbreviation and number only (not by title) and are not further identified.

C. When the effective date of a reference standard is not given, if the date given has been superseded, it shall be understood that the current edition or latest revision thereof, and any amendments or supplements thereto, in effect shall govern the work.

D. Reference standards are not furnished with the contract documents. The Contractor shall obtain copies of referenced standards direct from publication sources as needed for proper performance and completion of the work and provide and maintain referenced standards at the job site field office. The Architect/Engineer will furnish, upon request, information as to how copies of specified standards may be obtained.

1.05 ABBREVIATIONS

Whenever in the specifications the abbreviation or acronym is specified, it shall be understood to mean the full name of the respective organization, as follows:

AAMA  American Architectural Manufacturer's Association
ACI    American Concrete Institute
ADA    Americans with Disabilities Act
ADAAG  Americans with Disabilities Act Accessibility Guidelines
AIA    American Institute of Architects
AIMA   Acoustical and Insulating Materials Association
AISC   American Institute of Steel Construction
ANSI   American National Standards Institute
APA    American Plywood Association
ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
ASTM   American Society for Testing and Materials
AWPA   American Wood Preservers Association
AWPB   American Wood Preservers Bureau
AWPI   American Wood Preservers Institute
AWS    American Welding Society
AWI  Architectural Woodwork Institute
BHMA  Builders’ Hardware Manufacturer’s Association
CRSI  Concrete Reinforcing Steel Institute
CDA  Copper Development Association
DHI  Door and Hardware Institute
FGMA  Flat Glass Marketing Association
FS  Federal Specification (also abbreviated Fed. Spec.)
HMMA  Hollow Metal Manufacturer's Association
ICBO  International Conference of Building Officials
IEEE  Institute of Electrical and Electronics Engineers
IFB  Invitation for Bids
NAAMM  National Association of Architectural Metal Manufacturers
NBFU  National Board of Fire Underwriters
NCMA  National Concrete Masonry Association
NEC  National Electric Code
NEMA  National Electrical Manufacturers Association
NFPA  National Fire Protection Association
NWMA  National Woodwork Manufacturer's Association
MBMA  Metal Building Manufacturer's Association
PCA  Portland Cement Association
PDCA  Painting and Decorating Contractors of America
PIB  Plastering Industry Bureau
PS  U.S. Department of Commerce Product Standard
PUC  Public Utilities Commission
RIS  Redwood Inspection Service
SMDI  Steel Door Institute
SMACNA  Sheet Metal and Air Conditioning Contractor's National Association
SWI  Sealant and Waterproofers Institute
SSPC  Steel Structures Painting Council
TCA  Tile Council of America
UBC  Uniform Building Code
UMC  Uniform Mechanical Code
UL  Underwriters’ Laboratories, Inc.
UPC  Uniform Plumbing Code
WCLIB  West Coast Lumber Inspection Bureau
WWPA  Western Wood Products Association

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION
SECTION 01500 - CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

As specified in SECTION 01001- GENERAL REQUIREMENTS.

1.02 CONSTRUCTION REQUIREMENTS

A. Consult with the University, review site conditions and factors which affect construction procedures and construction aids, including adjacent public facilities and properties which may be affected by execution of the work.

B. Relocate construction aids as required by progress of construction, by storage, or by work requirements, and to accommodate legitimate requirements of the University and other Contractors employed at the site.

C. In addition to indicated staging and parking areas available for the Project, at a time not later than the Pre-Bid Conference, verify from the University acceptable methods Contractor may conduct his own day to day business on Site and for conducting OAC meetings.

1.03 ELECTRICITY AND WATER

All temporary electrical wiring and connection to existing service shall be furnished and paid for by the Contractor. Provide branch wiring and distribution boxes located to allow service and lighting by means of construction type power cords. All temporary water lines and appurtenances required for construction shall be supplied and paid for by the Contractor. The University will pay for electrical and water use.

1.04 SANITARY FACILITIES

Provide portable facilities as required for the Work and in accordance with the Health Authorities. Maintain and clean on a regular program acceptable to the University.

1.05 CONSTRUCTION AIDS

Provide construction aids and equipment required by construction personnel and to facilitate execution of the work including: scaffolds, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes and other such facilities and equipment.
1.06 TEMPORARY PROTECTION

A. Safety Barricades (Construction Fence):

1. The Contractor shall erect and maintain a temporary safety barricade a minimum of 5'-0" outside the project area as applicable, encompassing the project area to protect the occupants and the public. The barricade shall remain during the duration of the project or until approval is given by the University for its removal.

2. Provide a ten foot (10'-0") high lumber framed and plywood sheathed fence with man gates and vehicle gates as required for proper access to the Site. Gates to be lockable and locked as required to ensure security and safety of the public and Site. Engineer fence for structural stability. Paint fence and maintain in good condition for full Contract Period. Paint color(s) to be selected by the University. Where dust barrier may be required to be added as an extension to any safety barricade, engineer fence to ensure that the overall barricade is structurally stable.

B. Dust Barricade: When instructed by the University, the Contractor shall provide a dust barricade enclosure to confine the dust from spreading from its immediate area.

C. Any damage to the surrounding buildings, its contents, etc., from failure to provide the protection as mentioned in the above paragraphs shall be made good by the Contractor to the satisfaction of the University and at no cost to the University.

D. Signs: The Contractor shall provide, post, and maintain any and all required warning signs. All warning signs shall meet OSHA requirements regarding color, size, and lettering. Signs shall be clearly legible at all times. Signs with freehand lettering are not permitted.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION
SECTION 01567 - POLLUTION CONTROL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

As specified in SECTION 01001- GENERAL REQUIREMENTS.

1.02 RUBBISH DISPOSAL

A. No burning of debris and/or waste materials shall be permitted on the
   project site.

B. No burying of debris and/or waste materials.

C. All unusable debris and waste materials shall be hauled away to an
   appropriate off-site dump area. During loading operations, debris, and
   waste materials shall be watered down to allay dust.

D. No dry sweeping shall be permitted in cleaning rubbish and fines which can
   become airborne from floors or other paved areas. Vacuuming, wet
   mopping, or wet or damp sweeping is permissible.

E. Enclosed chutes and/or containers shall be used for conveying debris from
   above ground floor level.

F. Clean-up shall include the collection of all waste paper wrapping materials,
   cans, bottles, construction waste materials, and other objectionable
   materials, and removal as required. Frequency of clean-up shall coincide
   with rubbish producing events.

G. Bag all hazardous debris such as hardwood floor shavings etc. Dispose off
   site.

1.03 DUST

A. Dust shall be kept within acceptable levels at all times, including non-
   working hours, weekends and holidays in conformance with Chapter 11-
   60.1-33 FUGITIVE DUST, as amended, of the State Department of Health,
   Hawaii Administrative Rules.

B. The method of dust control and all costs incurred thereof shall be the
   responsibility of the Contractor.

C. The Contractor shall be responsible for all damage claims in accordance
   with provisions pertaining to INDEMNIFICATION and INSURANCE of the
   IFB/Contract.
1.04 **NOISE**

A. Noise shall be kept within acceptable levels at all times in conformance with Chapter 46 - Community Noise Control, State Department of Health, Hawaii Administrative Rules. The Contractor shall obtain and pay for community noise permits from the State Department of Health when the construction equipment or other devices emit noise at levels exceeding the allowable limits.

B. All internal combustion engine-powered equipment shall have mufflers to minimize noise and shall be properly maintained to reduce noise to acceptable levels.

C. Starting up of on-site vehicular equipment meeting allowable noise limits shall not be done prior to 7:30 a.m. or after 4:30 p.m. without prior approval of the University. Equipment exceeding allowable noise limits shall not be started up prior to 8:00 a.m.

1.05 **ODORS**

Construction involving products generating noxious odors shall be scheduled with the University so as to reduce high levels of exposure to occupants. Products with noxious odors include but are not necessarily limited to the following: carpet adhesives, paint, asphalt, epoxy, and various resins etc. At the commencement of project, Contractor shall submit a list of all products with potentially noxious odors and pertinent data on each product. Construction involving the use of a roofing kettle shall be required to use an emission reducer.

1.06 **OTHERS**

A. Wherever trucks and/or vehicles leave the site and enter surrounding paved streets, the Contractor shall prevent any material from being carried onto the pavement. Waste water shall not be discharged into existing streams, waterways or drainage systems such as gutters and catch basins unless treated to comply with Department of Health pollution regulations.

B. Trucks hauling debris shall be covered as required by PUC Regulations. Trucks hauling fine materials shall be covered.

C. No dumping of waste concrete will be permitted at the job site unless otherwise permitted in the SPECIAL PROVISIONS.

D. Except for rinsing of the hopper and delivery chute, and for wheel washing where required, concrete trucks shall not be cleaned on the job site.

E. Except in an emergency, such as mechanical breakdown, all vehicle fueling and maintenance shall be done in a designated area. A temporary berm shall be constructed around the area when runoff can cause problems.
1.07 **SUSPENSION OF WORK**

Violation of any of the above requirements or any other pollution control requirement which may be specified in the Technical Specifications herein shall be cause for suspension of the work creating such violation. No additional compensation shall be due the Contractor for remedial measures to correct the offense. Also, no extension of time will be granted for delays caused by such suspensions.

If no corrective action is taken by the Contractor within 72 hours after a suspension is ordered by the University, the University reserves the right to take whatever action is necessary to correct the situation and to deduct all costs incurred by the University in taking such action from monies due the Contractor.

1.08 **DAILY CLEAN-UP**

A. Execute cleaning to keep work, the site and adjacent properties or areas free from accumulation of waste materials, rubbish and windblown debris, resulting from construction operation. Follow all current applicable laws.

B. Provide on-site containers for the collection of waste materials, debris and rubbish. Coordinate location of containers with the University.

C. Contractor shall vacuum and clean particles from ceiling and walls that fall on desk, chairs and floors etc. Contractor will be responsible for moving or covering all furniture in work areas and replacing at the end of the day.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION (NOT USED)**

END OF SECTION
SECTION 01600 – COMMON PRODUCT REQUIREMENTS - GENERAL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:

As specified in Section 01001.

1.02 SUMMARY:

A. Section Includes:

1. General requirements for products.

B. Related Sections:

1. Division 1 Sections, general.
2. Division 1 – Cleaning.

1.03 DEFINITIONS:

A. Primary Products: For any given product related Specification Section, the main product or products required for the Project; which is the reason such Specification Section is written.

B. Related Products: Products required to complete each installation of a primary product.

C. Defects: Anything about any Project product that would make it less in quality than the intended Contract requirements, e.g., materials not complying with Contract requirements, manufacturing defects, installation defects, damages prior to Contract conclusion, abnormal deterioration, etc., that occur prior to end of any warranties in effect and prior to a reasonable expected life cycle under similar installation conditions and exposures.

D. Exposures: Refer to Division 1 – References Section for definitions of "exterior", "interior", "exposed", "semi-exposed", and "concealed"; except as otherwise specified, e.g. Division 6 – Architectural Woodwork Section.

1.04 SYSTEM DESCRIPTION:

A. Performance:

1. General: Each product provided shall perform to the Contract requirements under the anticipated conditions of use and installation or exceed such requirements. Performance evaluation of any product to include the performance of the product by itself and its performance relative to the total assembly for which it is a part as exposed to actual installed Project environmental and use conditions.
2. **Authority Requirements:** Whether specified or not, each Project product to meet all Codes, laws, and other Authority applicable requirements that apply to each product. For any particular product, where specifications does not address any Project applicable Authority requirement, include in Bid the Manufacturer’s Code compliant product; which is comparable to original product and that does not jeopardize original Project design intent specified for any such product. Secure University’s approval of product; before purchase, fabrication, and installation of such products.

B. **Toxic Material Restrictions:**

1. **General:** Do not use materials scheduled to be incorporated as part of any permanent construction when such materials are toxic or can produce toxic-like reactions, or both; in humans and under following conditions, unless otherwise acceptable to University.


   b. Where current scientific medical research seems to indicate a potential for toxicity or toxic-like reactions to humans; when not conforming strictly to accepted conditions of its installation.

   c. Where known to contribute to “sick building syndrome”; e.g. those containing unsafe levels of volatile organic compounds; those containing unsafe levels of heavy metals; producing intolerable levels of undesirable odors; that can result in nausea, headaches, and other abnormal effects in humans.

   d. Cannot be sealed in permanently by other construction materials in manner that it is no longer a potential source of toxicity or toxic-like reactions to humans; in short term and in future.

2. **Objectionable Odors:** Non-restricted materials may be used, but odor levels to have dissipated to levels as not to be objectionable at time of University’s first occupancy of any area of Project.

1.05 **SUBMITTALS:**

A. **List of Products:** As a condition to securing the Contract for the Work, submit a list of primary products to be used for the Work, prior to signing the Contract for the Work. Secure the University’s general approval of the listed products. List products under each related Specification number. List of Products to indicate product, Manufacturer, Installer, and Supplier.

B. **Work Related Submittals:**

1. **Specified:** Refer to other related Sections as follows.

   a. Division 1 - Submittals.
b. Individual Specification Sections applicable to each Entity.

2. Unspecified: Including substitutions, submit any and all documentation required by University in order to determine compliance with intent of Project.

C. Closeout Submittals: Refer to “Warranty” and “Maintenance” paragraphs herein.

1.06 QUALITY ASSURANCE:

A. Intent of Section: Requirements specified herein are minimum quality standards that apply to all products required for Project; whether requirements are specified or not and are to be complied with unless otherwise acceptable to University.

B. Manufacturer, Supplier, Fabricator, Installer Qualifications:

1. General Qualifications: Notify University where any of following qualifications cannot be met.

a. The Manufacturer best understands the performances of Its’ products relative to Project’s requirements.

b. Those working with any Project products, e.g. Installer and Fabricator, has secured proper Manufacturer training to professionally fabricate and install their products in accordance with Manufacturer’s Project specific design intent.

c. Those working with any Project products, e.g. Installer and Fabricator, has fully disclosed and secured written confirmation of specific Project requirements for each Manufacturer’s product from reliable and knowledgeable Manufacturer’s Technical Representatives; prior to Bid and has incorporated such requirements into Bid.

d. Those working with any Project products, e.g. Installer and Fabricator, have an intimate knowledge of all the available characteristics and options necessary to provide a complete installation in accordance with Contract design intent.

2. Experience: Except as otherwise indicated, as follows.

a. Type: Current and continuous experience with the specific Project required products and services being provided or equivalent experience acceptable to Product Manufacturer and University.

b. Number of Years: Not less than following.

1) Manufacturer: 10.
2) **Supplier:** 5.

3) **Fabricator:** 10.

4) **Installer:** 5.

3. **Certification:**
   
a. **Requirement:** Where Manufacturer has a certification or licensing program for installation of Project products, Installer to possess current certification or licensing. Certification to have been attained not less than two years prior to time that Project was Bid.

   b. **Submittal:** Submit written documentation of such certification when specified or requested by University.

4. **Verification of Project Requirements:**
   
a. **Condition of the Contract:** It is the responsibility of the Installer and Fabricator of each work to verify that each Manufacturer’s product can meet the specified and drawn Project requirements applicable to the Work; including each Manufacturer’s Project related requirements and Industry practices and standards. Verify requirements during Bidding and prior to signing the Contract for the Work by the Contractor.

   b. **Impact:** Where University has not been notified prior to the signing of the Contract for the Work by the Contractor, Entities responsible for such work, including Contractor, are required to provide work necessary to comply with specified requirements at no additional cost to University.

C. **Fire Rated Assemblies:**

   1. **Intent:** Provide each installed assembly to exactly match each required Product Manufacturer’s tested fire assembly applicable to Project fire rating condition.

   2. **Alteration:** “Engineering Judgments” or other alterations of Manufacturer’s fire tested assemblies are not allowed; except as follows.
      
      a. **Unless acceptable to University.**

      b. **Manufacturer submits written acceptance of fire performance; without limitation.**

D. **Related Products:**

   1. **Intent:** Each related product required to complete the installation of a primary Project product and having a performance related impact on a
specific Project product to be approved in writing by the Manufacturer of the primary Project product for use on the Project and for each scheduled type of use on Project; whether provided by them or not.

2. **Conflict:** Where specified requirements are detrimental to performances and not acceptable to any Manufacturer, notify University for resolution of such conflict; prior to purchase, fabrication, and manufacture of such products.

E. **Manufacturer’s Packaging and Labels:**

1. **General:** Keep intact and unopened until just prior to each installation. Packaging may be opened when required by Manufacturer to protect products from damages due to environmental conditions, e.g. condensation, humidity, etc., and only to extent as required by them. When required, maintain protections of products.

2. **Label Descriptions:** Labels to identify Project products. Specified special performances and Authority required information to appear on labels.

F. **Scheduled Colors:** Where any Manufacturer’s product color is specified on Drawings or Schedules separate from Specifications, such color is not an approval of Manufacturer’s product for use on Project; unless such product complies in every way to requirements of specifications in Project Manual applicable to Project product, e.g. color of vinyl product is scheduled, but specifications requires rubber product and color of a particular Paint Manufacturer is scheduled, but is not an approved listed acceptable Paint

G. **Manufacturer in the specifications.** Where specified product has no matching color; secure University’s directive prior to purchase and fabrication of any affected product.

1.07 **WARRANTY:**

A. **Warranty Definitions:**

1. **Manufacturing Defects Warranty:**

   a. **Definition:** Provides for University remedies from Warrantor for manufacturing defects in materials and its workmanship during manufacturing process; arising under installed conditions within specified warranty period.

   b. **Remedies:** As indicated in published warranties, but covers not less than replacement material shipped to University at Manufacturer’s cost or refund of original purchase cost for defective materials.
c. **Exclusions:** Not more than following.
   

   2) Incidental and consequential damages resulting from defects.

   3) Misuse of product by University.

   4) Costs for installing replacement materials.

2. **Installation Defects Warranty:**
   
   a. **Definition:** Provides for University remedies from Warrantor for installation defects arising under installed conditions in materials as a result of improper workmanship during its installation and within specified warranty period.

   b. **Remedies:** Covers not less than costs by Warrantor for labor and materials necessary to rectify defective conditions to meet original Contract intent; including damages to adjacent work as a result of restoration work.

   c. **Exclusions:** Not more than following.


      2) Incidental and consequential damages resulting from defects.

      3) Misuse of product by University.

3. **Manufacturing and Installation Defects Warranty:**
   
   a. **Definition:** Provides for University remedies equally from several Warrantors for manufacturing and installation defects arising under installed conditions in materials and its workmanship within specified warranty period.

   b. **Remedies:** Covers all costs by Warrantor(s) for labor and materials necessary to rectify defective conditions to meet original Contract intent; including damages to adjacent work as a result of restoration work.

   c. **Exclusions:** Not more than following.


      2) Incidental and consequential damages resulting from defects.

      3) Misuse of product by University.
4. **Start of Warranty Period:** Warranty Period to start from date certified for Substantial Completion by University; unless another start period is specified.

B. **Contractor’s Project Warranty:** Refer to General and Supplementary Conditions of the Contract.

C. **Manufacturer’s Standard Warrantees:** Whether specified or not, submit standard available “Manufacturing Defects” warrantees for primary Project products. All products to have not less than a one (1) year warranty; except where any required Special Warrantees provide for additional coverage above and beyond Installer’s One Year Warranty.

D. **Installer’s Warrantees:** Whether specified or not, submit each Installer’s one (1) year “Installation Defects” Warranty; except where any required Special Warrantees provide for additional coverage above and beyond Installer’s One Year Warranty.

E. **Special Warrantees:**

1. **General:** Refer to individual Specification Sections for other warrantees required for Project.

2. **Definition:** Special Warrantees provide for University remedies that are in addition to Warrantor’s One Year Warrantees required for Project.

3. **University’s Approval:** For any Warranty in which the warranty period is in excess of one (1) year, secure University’s approval of Warranty conditions, prior to purchase and manufacture of any Project products. Provide following to University.

   a. **Submittal:** Project representative sample copy of unexecuted Warranty stating obligations, remedies, exclusions, and restrictions.

   b. **University’s Review:** If required, clearly explain conditions of Warranty to University. Manufacturer’s Company personnel providing explanations are to be legally knowledgeable about their warrantees.

F. **Surety Responsibility:** For Warrantees backed by a Surety, the Surety is not liable for periods beyond two (2) years, however, the primary Warrantor offering a Project Warranty, in which a Surety is involved, is directly responsible for their Warranty after the two year period and for the length of the Warranty Period indicated.

1.08 **MAINTENANCE:**

A. **Maintenance & Servicing Instructions:** Submit following. These are in addition to any similar requirements specified in other Specification
Sections.

1. **Standard Publications**: Whether specified or not, submit standard published user manuals for operation and maintenance of Project materials and equipment.

2. **Project Specific Data**: Data not part of standard publications; due to Manufacturer’s customizations to meet Project intent and which is important to proper operation and maintenance of each installed product.

B. **Extra Materials**: Unless following specified conditions are modified by other language, following to apply.

1. **Packaging**: Each material is to be packaged in manner to accomplish following; unless otherwise acceptable to University.
   a. Protected in manner similar to how Manufacturer ships original materials to Project.
   b. Packaging to be of reasonable size to allow for portability by Maintenance Personnel by manual or typical equipment in possession of University.
   c. Permanently marked so University can recognize exact contents of each packaged material. Markings to be readily identifiable on packaging and legible.

2. **Delivery**: Deliver to each University’s on Site location as directed by University.

**PART 2 - PRODUCTS**

2.01 **PRODUCTS, GENERAL**: 

A. **Primary Product**: Unless otherwise specified or acceptable to University, products to comply with following.

1. **Experience**: Used 10 years minimum in projects of similar type, scope, under similar environmental conditions, and under the same installation (assembly) conditions.

2. **Compatibility**: Compatible with related products required to complete each of its installation and compatible with each interfacing product in each assembly.

3. **Single Source Intent**: For specified primary products in any particular Section, the indicated products are to be generally provided by a single Manufacturer; unless it is clear that specified requirements cannot be met by a single Manufacturer; then limit number of sources
to fewest reasonably possible.

B. **Related Products:** Refer to “Quality Assurance” paragraphs herein.

C. **Completeness:** Provide all materials necessary to provide a complete and fully functional assembly for each product required for Project.

D. **Finishes of Related Products:** For exposed components of related products, provide same finish as required for primary product; unless otherwise specified or acceptable to University.

### 2.02 FABRICATION:

A. **Project Measurements:** Establish written documentation with Contractor coordinating measurements and tolerances required to assure that fabricated work fits final intended Project outcome. Where possible verify actual field conditions prior to final fabrication of Project units affected by field conditions.

B. **Manufacturing Products - Intent:**

1. **General:** Generally specified requirements for any product are those which can be met by standard established manufacturing practices of manufacturers producing types of products required for Project. Generally do not alter the manufacture of such products; except as specifically engineered by Manufacturer to conform their products to meet required special or custom intent of Contract.

2. **Customizations:** When required, Manufacturer to have ten (10) years minimum experience engineering products for specific custom performances required for Project; unless otherwise acceptable to University.

3. **Acclimation Sensitive Products:** Where products are sensitive to environmental conditions, adjust manufacturing and fabrication of products in manner that defects do not occur under final environmental conditions to which product is to be exposed.

4. **Handing:** Where functional products are “handed”; e.g. left or right swing equipment doors, and where handing is not indicated, submit schedule to University for review of handing; prior to purchase and manufacture of products.

### 2.03 SPECIAL REQUIREMENTS:

A. **Ferrous Products – General:** Whether required for exterior or interior use and unless otherwise acceptable to University, comply with following.

1. Do not install any rusted ferrous products in the Work. If rust occurs, rust to be removed completely from surfaces without destroying functionality of product or replaced with new un-rusted and Contract
complying work.

2. Ferrous fasteners when used with metals are to be used only with ferrous materials.

B. **Galvanizing of Ferrous Metal Products:** Even when not specified, and except where other galvanizing specified, ferrous metal products to be hot dipped galvanized as follows.

1. **Location:**
   a. When part of exterior assemblies, including vented attic spaces exposed to exterior air.
   b. At interior when installed in or attached to concrete and masonry part of exterior wall or similar assemblies.
   c. When occurring in wet or high humidity areas, e.g., restrooms, janitor’s closets with sinks, kitchens, swimming pools, shower areas, steam rooms, saunas, etc.

2. **Type of Galvanizing:** As applicable to assembly type, comply with following:
   a. **Standard:** ASTM A 153, ASTM A 123, and ASTM A 653.
   b. **Vent Holes:** If required, fully plug flush with lead after galvanizing. Blended smooth with adjacent surfaces.

C. **Stainless Steel:** If any, to be products to be fabricated without ferrous contamination in accordance with NiDI requirements.

**PART 3 - EXECUTION**

3.01 **GENERAL EXECUTION REQUIREMENTS:**

A. **Intent:** Comply with Manufacturer’s Project specific requirements as fully submitted and successfully reviewed by University; which shall not be less in quality than Contract intent and applicable Industry standards.

3.02 **DELIVERY, STORAGE, & HANDLING:**

A. **Delivery:** Upon arrival at Site, immediately inspect products for defects. Replace defective products in timely manner; without affecting Project Progress Schedule.

B. **Storage:** Comply with each Manufacturer’s Project specific requirements. Ensure storage methods do not cause defects to occur. Whether storage is on site or off site, maintain insurance covering full replacement of materials.
C. **Handling:** Use methods and equipment approved by each Product Manufacturer for types of handling required in Project.

D. **Protection of Products:**

1. **Intent:** Contract requirements cannot anticipate Contractor’s means and methods for shipping products to Site and its storage on Site, e.g., overseas shipping of ferrous products where exposure conditions can rust product. Specified requirements are intended for University acceptance of installed undamaged and un-deteriorated, as-manufactured products at time of Substantial Completion.

2. **Protection Responsibility:** Contractor is responsible for means and methods, including interim shipping and storage, to ensure Project products are provided with adequate protections during entire procurement and installation process; so products can be installed accordance with Contract intent.

### 3.03 PROJECT SITE CONDITIONS:

A. **Environmental Conditions:** Do not proceed with any work under any adverse conditions that would cause defects in products.

B. **Acclimation:**

1. **General:** Acclimate interior products prior to each installation under Manufacturer recommended environmental conditions to ensure success of each installation.

2. **Interior Products:** Install when each space fully enclosed and when temperature and humidity are in strict accordance with each Product Manufacturer's requirements.

### 3.04 SEQUENCING & SCHEDULING:

A. **Coordination:** Each Installer to coordinate work with other Trades, e.g., schedules, sequence of operations, dimensions, tolerances, finish, embedded items, templates, etc., to ensure work by other Trades are constructed in manner to ensure success each of their installations.

### 3.05 EXAMINATION:

A. **Existing Conditions:** Prior to start of each work, verify existing conditions for conformance with requirements necessary to ensure success of each installation. Start of work indicates acceptance of conditions and confirms its conformance.

### 3.06 PREPARATION:

A. **Responsibility:** Each Installer to verify and coordinate following responsibilities; otherwise Installer requiring preparation is required to provide required work necessary to assure success of its installation.
1. Support work.

2. Substrate preparation.

3. Tolerances.

3.07 INSTALLATION:

A. **General:** Refer to “General Execution Requirements” paragraph herein.

B. **Finish, Color, Pattern, Texture Variation:** Install products in manner to assure uniform visual appearance acceptable to the University. Methods for insuring uniformity may include utilizing materials in sequence as manufactured from same lots where singular lot may be used for single contiguous area or may require the hand selection of materials between several lots for larger areas.

C. **Defective Work:**

1. **General:** Replace defective work with complying work; unless otherwise acceptable to University.

2. **Minor Defects:**

   a. **General:** Very minor damage, deterioration, and other very minor defects may be restored when acceptable to the University.

   b. **Extent of Restoration:** For any exposed to view work, the extent of restoration, e.g. many minor abraded paint coatings, in any area may not be acceptable, unless the restoration is not visible.

3. **Restoration Intent:** In addition to any other requirements, restoration when allowed by University shall meet following minimum criteria.

   a. After fully finished, no evidence of restoration work to be visible where on any exposed to view surfaces.

   b. Workmanship of restoration work on concealed surfaces may be less rigorous than work for exposed to view surfaces, but to be generally flush and neat.

   c. The existing defect and any restoration work is not to reduce the long term performance of the materials and components of the work in any way.

   d. The method and materials used to restore any defect to be such that it can perform as well or better than the original materials.

   e. Restoration is to be accomplished at no cost to University.

3.08 PROTECTION:
A. **Intent:** Provide protections necessary so each work is clean, without contamination, without defects, abnormal deterioration, without damage, and properly functioning at the time of Final Acceptance by the University.

3.09 **CLEANING:**

A. **Intent:** Refer to Division 1 - Cleaning Section.

END OF SECTION
SECTION 01605 – COMMON PRODUCT REQUIREMENTS - FASTENERS & ANCHORS

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Metal fasteners and anchors.
   B. Related Sections:
      1. Division 1 Sections.
      2. All sections requiring fasteners and anchors.

1.03 SYSTEM DESCRIPTION:
   A. Engineered Performances:
      1. General: Except for Code required structural performances as shown on Structural Drawings, each Installer to be responsible for proper selection and engineering of fastening devices for structural performances and applicability to conditions of fastening and anchorage.
      2. Wind Load Performances: Where windload performances are required, provide fasteners engineered and tested for such performances with stress distribution heads, washers, or of other Manufacturer design to minimize pull through under wind loads.
      3. Expansion Anchors: ASTM E 488 load capability, without failure, as follows.
         a. Masonry: Load equal to 6 times imposed load.
         b. Concrete: Load equal to 4 times imposed load.

1.04 QUALITY ASSURANCE:
   A. Single Source Responsibility: Secure each type of product from a single Manufacturer.
   B. Fastener and Anchor Types: All indicated types may not be required for this Project, but when required are to comply with requirements herein.
C. Contrary to Manufacturer Requirements: Do not purchase and fabricate any product or material required for this Project, where Manufacturer does not approve of the specified requirements for fasteners specified herein. Secure Architect’s direction prior to purchase and fabrication of such products or materials.

D. Exposed and Semi-Exposed Surfaces: Unless otherwise specified, comply with following.

1. Wood: Countersink fasteners for full concealment; unless otherwise acceptable to Architect. Wood filler for small diameter nails and wood plug for larger diameter nails and screws. Where no product exists that can be countersunk without jeopardizing performances and Product Manufacturer does not allow countersinking, notify Architect.

2. Other Materials: Fabricate products for concealed fasteners wherever possible; otherwise flush countersunk flathead devices.

E. Penetration:

1. General: Penetrate through anchored material into anchoring material to depths required for holding and structural performances.

2. Exposure: No fasteners secured from opposite side are to penetrate through any material and be exposed to view in any habitable space.

F. Metal Framing Anchors: When required by Architect, submit research/evaluation reports indicating compliance with requirements of Building Code or Authorities.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Cast:


2. Stainless Steel: AISI Type 304 alloy minimum.

3. Brass and Bronze: Same alloy as fastened component.

4. Aluminum: Same alloy as fastened component.
B. Sheet:


2. Stainless-Steel Sheet: ASTM A 666, Type 304 minimum.

C. Paint Finishes: Where surfaces of fastening devices are exposed on fastened substrate, comply with following.

1. Painted Fastened Substrate: Same paint coating as fastened component. Where not available then provide not less than urethane, TGIC powder, or epoxy in same sheen and color as fastened component.

2. Fastened Substrate Scheduled for Field Applied Paint Coatings: Apply same finish coating using appropriate primer over fastening device.

3. Fastened Substrate with No Paint Coatings: Fastener to be of base material as specified herein.

2.02 STANDARD STAINLESS STEEL TYPES:

A. General: Comply with SSINA "Stainless Steel Fasteners" for each type, except 300 series minimum, unless specific alloy specified.

2.03 STANDARD FERROUS TYPES:

A. Power-Driven Fasteners: CABO NER-272.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Screws:

1. For Wood: ASME B18.6.1.

2. For Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings.


D. Bolts:


2. Lag Bolts: ASME B18.2.1.

E. Expansion Anchors:
   2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

F. Other:
   1. Anchor Bolts: ASTM F 1554, Grade 36.

PART 3 - EXECUTION

3.01 INSTALLATION:
   A. General: Comply with Project specific engineered requirements of each Fastened Product Manufacturer; to comply with the Contract intent.
   B. Structural Fasteners: Refer to Structural Drawings and Specification Sections that is in compliance with requirements in this Section.
   C. Other Fasteners: Comply with Project Code requirements for the fastening of each type of work covered by the Project Code.

3.02 SCHEDULE:
   A. Standard Anchorage Devices:
      1. Brass, Bronze, and Aluminum Fasteners: May be used when complying with following.
         a. Must be of same alloy or compatible alloy as the fastened component of brass, bronze, or copper.
         b. Engineered for required structural performances.
         c. Does not deteriorate at a faster rate than the fastened component from any corrosive conditions.
      2. Stainless Steel Fasteners: For following.
         a. When specified.
b. Except for brass, bronze, and aluminum fastened materials, use for all fastened materials and products part of and attached to exterior facing side of base substrate, e.g., metal studs, concrete, or masonry; whether concealed or exposed. Do not use stainless steel where such material would be cause of electrolytic deterioration to fastener or fastened material at a faster rate than using fasteners of other materials.

c. Fastening of materials in interior wet areas, e.g., showers, saunas, and steam rooms; except restrooms.

3. Galvanized Fasteners: For following.

a. Fastening of exterior materials, except where stainless steel, brass, bronze, and aluminum required.

b. Fastening of interior galvanized steel materials.

c. Fastening of materials in restrooms.

4. Other Metal Fasteners: Any interior fastened materials standard with Manufacturer of fastened product; unless other specified fasteners required.

END OF SECTION
SECTION 01700 – CONTRACT CLOSE OUT

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

As specified in SECTION 01001 GENERAL REQUIREMENTS.

1.02 CLOSEOUT PROCEDURES

A. When work has reached final completion, submit written notification that the contract documents have been reviewed, the work has been examined, and that the work is complete in accordance with contract documents and ready for University’s inspection.

B. A final inspection to determine acceptance of the project will be performed by the Contractor, Architect/Engineer and University representative.

C. From the information gathered from this inspection, the University will prepare a “punch list” of work to be performed before the project will be accepted. All work on the punch list shall be completed by the Contractor prior to acceptance of the project by the University.

D. In addition to submittals required by the conditions of the contract, provide submittals required by governing authorities, and submit a final statement of accounting, on forms provided by the University.

E. Execute final cleaning prior to final inspection.

1.03 PROJECT RECORD DOCUMENTS

Store documents separate from those used for construction. Keep documents (As-Built) current and do not permanently conceal any work until required information has been recorded. At contract closeout, submit documents with transmittal letter.

1.04 WARRANTIES

Provide triplicate notarized copies. Execute submittals and assemble documents executed by subcontractors, suppliers, and manufacturers. Submit materials prior to final application for payment. Warranties shall begin from the date of project acceptance. The Contractor shall be advised that the University shall have the right for beneficial use of all new equipment prior to project acceptance. It shall be the Contractor’s responsibility to obtain extended warranties for use of all new equipment provided by this contract prior to project acceptance at no additional cost to the University.
1.05 **MANUALS**

Contractor(s) shall furnish the University with four (4) complete sets of written service instructions and manufacturer operation catalogs and data, together with warranties and guarantees and such field instructions to University personnel as is necessary to fully instruct correct operating and maintenance procedures for equipment installed under this contract. Data and instructions shall be furnished for equipment requiring periodic adjustment, maintenance or other operating procedure, include also the hardware, accessories, heating, ventilating, air conditioning, plumbing, and electrical work.

1.06 **FINAL CLEANING**

A. At the completion of the project, prior to acceptance and prior to the final inspection, thoroughly clean the job site, buildings and work areas. Vacuum clean where appropriate and remove grease, adhesive, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces. Use commercial cleaning compounds where necessary. Wash and shine glazing and mirrors. Polish glossy surfaces to a clean shine. Wash and wax all resilient floors, clean all tile flooring and similar surfaces. Clean all painted surfaces where soiled. Clean all toilets including fixtures and partitions. Clean and leave in like-new condition all surfaces not specifically mentioned above.

B. If applicable, clean permanent filters of ventilating systems and replace disposable filters if units were operated during construction. Clean ducts, blowers, and coils if units were operated without filters during construction.

C. Follow the recommendations of the manufacturers of the materials and items to be cleaned for all cleaning.

D. Prior to final inspection, clean the site and put it into a neat, acceptable condition. Hose down and scrub where necessary all new pavement and walks, and all existing pavement and walks dirtied as a result of the work. Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces, and all work areas, to verify that the entire work is clean and ready for final inspection.

1.07 **RESTORATION OF SITE**

Contractor shall be held responsible for restoration of all lawn and grass areas and/or shrubs, landscaping, lawn sprinkler heads etc. damaged as a result of construction vehicles and Contractor’s vehicular parking.

**PART 2 – PRODUCTS** (NOT USED)
PART 3 – EXECUTION  (NOT USED)

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

General: As specified in Section 01001.

1.02 SUMMARY: This section includes the results of the University’s survey for materials and is provided for the Contractor’s information. The areas of the building were not surveyed for ACM. Lead-containing paint was identified in the scope of work areas.

PART 2 - MATERIALS (not used)

PART 3 - EXECUTION

3.01 SURVEY: Windward Community College Hale Imiloa Vet Tech Facility Lead Paint Testing Reports were developed by Kimura International on February 8, 2012. This report can be viewed at:

Facilities and Environmental Health Office
University of Hawaii-Community Colleges
2010 East West Road
(Delivery address, backside of UH Federal Credit Union house)
Honolulu, Hawaii 96822

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Cutting and patching requirements.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 3 – Concrete Repair.

1.03 DEFINITION:
   A. "Cutting and Patching": The phrase as used herein is defined as follows.
      1. Cutting and patching includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting and patching required to restore surface to their original condition.
      2. Cutting and patching is performed for coordination of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.
      3. Cutting and patching performed during the manufacture of products, or during the initial fabrication, erection or installation processes is not considered to be "cutting and patching" under this definition. Drilling of holes to install fasteners and similar operations are also not considered to be "cutting and patching".
      4. "Demolition" is recognized as related-but-separate category of work, which may or may not require cutting and patching as defined in this Section. Cutting and patching work required by demolition to comply with requirements of this Specification Section.

1.04 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: Submit Product Data on materials to be used in for patching work.
C. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraph herein.

1.05 **QUALITY ASSURANCE:**

A. **Scheduled Methods:** Submit methods for cutting and patching of work prior to execution of any cutting and patching work.

B. **Alternate Methods:** University will entertain alternate methods where accomplishing original intent of cutting and patching work. Submit recommended methods for review. Do not institute alternate methods, unless successful review is secured from University.

C. **Structural Work:**

1. **General:** Do not cut and patch any work in a manner that would result in a reduction of its load-carrying capacity or of its load-deflection ratio.

2. **Reinforced Concrete Structures:** Do not damage any reinforcing components part of reinforced concrete structures, by drilling, coring, cutting, or other similar operations; including, but not limited for, penetrations, expansion bolts, dowels, etc. Locate reinforcing components with pachometer or other reliable detecting device prior to initiating any potentially damaging operations. Where existing reinforcing components prevent work to be accomplished, notify and secure direction from University prior to conducting any operation.

D. **Operational and Safety Limitations:** Do not cut and patch operational elements or safety related components in a manner that would result in a reduction of their capacity to perform in the manner intended, including energy performance, or that would result in increased maintenance, or decreased operational life, or decreased safety.

E. **Matching of Exposed-to-View Surfaces:**

1. **Intent:** Cutting and patching work not evident in exposed, final finished, in-place work.

2. **Approvals:** University to approve following conditions, prior to execution of cutting and patching work.

   a. Work scheduled with other concealing type finishes, cannot be fully concealed after final finishes are applied, e.g. telegraphing through paint coatings.

   b. Work not scheduled with any concealing finishes cannot be blended in manner with existing surfaces so that patching is not readily evident to University.
3. **Mockups:** University approval to be achieved by mockup in existing work in areas selected by University.

F. **Concealed Surfaces:** Concealed work may be less rigorous in finishing and final appearance, but should be finished flush with adjacent surface with some attempt to smoothly transition the patching materials with adjacent surface.

### PART 2 - PRODUCTS

2.01 **MATERIALS:**

A. **General:** Except as otherwise indicated or as directed by the University, use materials for patching that are identical in appearance to existing materials (unless otherwise acceptable to University), result in equal or better performance characteristics than material being patched, e.g., if concrete is being patched and original concrete is 3500 psi, provide repair materials with at least 3500 psi minimum cured performance, and attain bond strengths acceptable to University.

### PART 3 - EXECUTION

3.01 **PERFORMANCE:**

A. **Personnel:** Employ skilled workmen to perform cutting and patching work.

B. **Cutting:** Cut the work using least destructive but effective methods. In general, it is intended that finish cut surfaces to be clean, straight, and smooth. Method of cutting should minimize damage to adjacent finished surfaces.

C. **Patching:** Patch and blend work with adjacent surfaces to obscure evidence of work to greatest extent possible by methods approved by University.

END OF SECTION
SECTION 01740 – CLEANING

PART 1 – GENERAL

1.01 GENERAL CONDITIONS

As specified in Section 01001.

1.02 SUMMARY:

A. Section Includes:
   1. Cleaning during construction.
   2. Final Project cleaning.
   3. Waste control.

B. Related Sections:
   1. Division 1 Sections, general.
   2. Division 1 - Construction Facilities.
   3. Division 1 - Pollution Control.

1.02 DEFINITIONS:

A. Clean:
   1. Relative to Installed Products: Products cleaned in accordance with Manufacturer’s recommended procedures, cleaning agents and equipment to remove trash, dust, dirt, stains, and mars from product and adjacent surfaces and areas. Polishing materials are included for materials typically polished. Intent is to restore all installed surfaces to a “like new” appearance and cleanliness.
   2. Relative to General Construction Trash and Debris: Comply with SECTION 01567 - POLLUTION CONTROL.

1.03 SUBMITTALS:

A. Product Data: If specified or requested by the University, submit cleaning data.

B. Closeout Submittals: Refer to “Maintenance” paragraphs herein.
1.04 QUALITY ASSURANCE:

A. General Construction Trash and Debris:
   1. Responsibility: Contractor is responsible for informing all Entities prior to signing Contract for the Work, the expected level of cleanliness expected by the University.
   2. Pest Control:
      a. Intent: Do not allow trash and debris to contribute to pest, e.g. rodents, roaches and ants, survival and spread. Institute appropriate removal and disposal methods to prevent this.
      b. Extermination: Where Contractor’s operations are responsible for spread and survival of any pests on Site, Contractor to pay for extermination and control of pests to satisfaction of the University.
   B. Vandalism: Since security of Site is Contractor’s responsibility, vandalistic damage, e.g. graffiti, to be rectified by Contractor in manner to restore damaged surfaces to Contract compliance.
   C. Restriction: No University trash receptacles are to be used for disposal of the Contractor's waste.

1.05 MAINTENANCE:

A. Maintenance Instructions: For primary materials in each Specification Section 2-16, submit each Manufacturer’s standard published maintenance instructions, whether specified or not. Instructions to include recommended materials, equipment, schedules, and procedures.

PART 2 – PRODUCTS

2.01 MATERIALS:

A. General: Use only cleaning materials, methods, and equipment recommended by the Manufacturer of the product to be cleaned; specifically for types of cleaning required. Materials utilized should not be detrimental to the original characteristics of the cleaned product.

PART 3 – EXECUTION
3.01 DURING CONSTRUCTION - GENERAL:

B. Premises:

1. General: Clean premises daily.

2. Enclosed and Remote Spaces: Remove trash and debris from enclosed and remote spaces, e.g. excavations, chases, plenums, attics, crawl spaces and constructed cavities. Do not allow trash and debris to be permanently enclosed behind such work.

C. Surfaces, General: Responsible parties to clean surfaces contaminated by them. Remove as quickly as needed to prevent permanent damage and to prevent any deterioration to surfaces. Seek written approval of methods for removal of contaminants from surfaces installed by others.

D. Existing Work: When work operations involves working with existing work, clean exposed, semi-exposed, and concealed components of dirt, mars, stains, etc., without damage and deterioration to such surfaces.

E. Construction Trash and Debris: Remove trash offsite daily to prevent obstructions and hazards, e.g., fire hazards, and as required to keep the Project reasonably clean and neat in appearance.

F. Hazardous Materials: Use in manner approved by Authorities. When not in use, contain in proper containers. Dispose of waste off Site in lawful manner.

3.02 AT TIME OF PRE-FINAL INSPECTION:

A. General: Schedule cleaning so that work can be inspected in clean condition at all scheduled inspections.

3.03 AT TIME OF FINAL INSPECTION:

A. General: Comply with same requirements of "Pre-Final" Inspection.

B. Product Specific Reminders: Cleaning Project to a “like new” condition also includes and are in addition to other cleaning required of following specific products.

1. HVAC Related:
   a. Install new clean sets of HVAC system filters; except washable filters may be washed to a clean condition.
   b. Clean HVAC equipment ducts, blowers, and coils to remove construction type dust and debris from system components.

2. Plumbing Related: Clean faucet filters in all fixtures.

3. Light Fixture Related: Replace all lamps.
SECTION 02220 – SITE DEMOLITION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Selective forensic demolition during Bid.
      2. Selective demolition during Contract Period.
      3. Salvageable work.
   B. Related Sections:
      1. Division 1 Sections, general.
      2. Division 1 – Cutting & Patching.
      3. Division 1 – Photographic Documentation.

1.03 SUBMITTALS:
   A. Quality Assurance Submittals: Refer to "Quality Assurance" paragraphs herein.

1.04 QUALITY ASSURANCE:
   A. Existing Work Not Scheduled to be Demolished:
      1. Intent: Ensure that work required to be retained is not demolished and damaged. Refer to demolition precision required as specified herein. All damaged and deteriorated work resulting from the demolition process to be repaired or replaced to a condition not less than it was existing prior to the time the demolition process was started.
      2. Photographs: Prior to the start of the demolition work, photograph the work immediately adjacent to each work to be demolished in accordance with Division 1 - Photographic Documentation Section and secure the University’s successful review of the photographs. Purpose of the photographs to record pre-demolition condition of the work to remain and that could potentially be damaged.
B. Forensic Demolition during Bid:

1. **Notification**: Contractor to notify the University of forensic demolition required during Bidding in order to determine scope of work required. Submit to the University types and extent of each forensic demolition required. Secure the University’s acceptance of demolition required or come to an agreement for dealing with potential concealed conditions.

2. **Extra Costs**: Extra costs for concealed conditions will not be allowed where any of following conditions applies. The University will determine whether extra costs, if any, are justified.
   
   a. Where forensic demolition not performed.
   
   b. Where forensic demolition performed, but concealed condition causing extra work was not reasonably determinable during forensic investigation.
   
   c. Where forensic demolition performed, but extent of forensic investigations was not adequate in number and scope; to extent that concealed condition causing extra work would have been a reasonable expectation to look for based upon the type of existing construction and Contract requirements.

3. **Demolition**: Carry out demolition procedures in accordance with this Section; when forensic demolition has been accepted by the University.

4. **University’s Acceptance of Forensic Demolition Proposal**: Acceptance of demolition is not an approval by the University that the proposed demolition is adequate for Contractor’s purpose of discovery to adequately Bid this Project. Purpose of University’s review and acceptance of Contractor’s proposals is to monitor potential impact of any Precontract demolition to the existing work only.

C. **Demolition Precision**: Unless otherwise acceptable to the University, adjust precision of demolition procedures to accomplish following intent.

   1. **Intent**: Refer to Division 1 – Cutting & Patching Section for general intent.
   
   2. **Effect on Appearance**: For exposed work, damage from demolition procedures not to be evident in final finished work.
   
   3. **Effect on Performance**: For any work, damage from demolition procedures not to reduce performances of remaining work in any way.

D. **Survey Controls**: Protect and maintain benchmarks and survey control points from disturbance during construction.
E. **Outages:** If outages are required for the Work, inform The University prior to signing Contract of proposed timing of such outages and arrange times agreed to with The University. Include time periods in Progress Schedule at start of Work. Inform The University prior to each outage.

1.05 **PROJECT CONDITIONS:**

A. **Temporary Controls:** Refer to Division 1 requirements.

B. **Salvageable Work:**

1. **University Removal:** All salvageable work that the University wishes to retain and is part of any work indicated to be demolished will be removed by the University prior to the start of the Work.

2. **Work for Reuse in Project:** Not required.

3. **Work Not for Re-use in Project:** All other work indicated for demolition and not scheduled for salvaging and reuse is to be removed immediately and legally disposed of off Site in legal manner as Contractor pleases. Such work will be considered the property of the Contractor.

4. **Employees:** Use employees with requisite skills and knowledge so each product can be removed without damage and deterioration.

5. **Damaged Work:** Where any salvaged work is damaged, replace damaged work with matching new work. Matching new work to be approved by The University, prior to purchase, manufacture and installation of any existing and replacement work for which replacements are necessary.

**PART 2 - PRODUCTS** (Not Used)

**PART 3 - EXECUTION**

3.01 **PREPARATION:**

A. **Temporary Controls - General:** Implement to ensure following.

1. Efficient and safe flow of traffic.

2. Protection of public.

3. Acceptable minimization of polluting operations.

4. Prevention of erosion and flooding of Site.

5. Protection of existing vegetation and structures to remain.
3.02 DEMOLITION OPERATIONS:

A. General:

1. **Standards:** Comply with ANSI A10.6 and DOSH, Chapter 131.

2. **Methods:** Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated and to result in final University intended finish. Implement surgical level type procedures over gross destruction methods when appropriate; including at line where existing work is to remain. Typically, sawcut work or provide “sawcut-like” work at line where demolition work and any existing work to remain coincide, or provide alternate methods acceptable to The University to ensure clean straight terminations in work.

3. **Maintaining Existing Structural Integrity:**

   a. **Imposed Loads:** Where Contractor's operations will impose unusual static or impact loads to structures, ensure that structure will be capable of sustaining applied loads by proper location and application of operations and equipment.

   b. **Supporting Elements:** Where existing structural supporting work is removed, ensure temporary and adequate supports are in-place prior to demolition of such work.

B. **Existing Built Structures:** Completely remove indicated structures; whether above or below grade or as otherwise acceptable to the University.

C. **Existing Utilities:** Completely remove existing utilities to be abandoned. Cap point where utility lines to remain are encountered.

D. **Disposal:** Remove and dispose of materials offsite in legal manner as they are removed.

E. **Damages:**

   1. **General:** Damages to adjacent remaining existing work to be replaced with new matching work; unless other restoration can be accomplished to satisfaction of the University.

   2. **Landscaping:** Existing damaged landscaping to be restored to a healthy condition. Secure Arborist as required. Where restoration is not acceptable to the University and Arborist was not secured, secure Arborist to ensure restoration and at no added cost to the Contract.

3.03 REINSTALLATION OF SALVAGED WORK:

A. **General:** None required.

END OF SECTION
SECTION 02363 – TERMITE CONTROL – SS SCREEN BARRIER SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Stainless steel (SS) screen barrier systems.
   B. Related Sections:
      1. Division 3 – Cast-In-Place Concrete.
      2. Division 4 – Concrete Masonry Units.
      3. Division 15 Sections.
      4. Division 16 Sections.
      5. Other new and existing work that affects the termite control barrier performance.

1.02 SYSTEM DESCRIPTION:
   A. Termite Control Design Intent: Provide a continuous termite barrier for the new work and as required to separate the new work from the adjacent work, if not protected with an existing SS Barrier System.

1.02 SUBMITTALS:
   A. Product Data: Submit all available data on the Project system. Coordinate material designations so that it can be readily identified with the materials used for each required Project termite barrier assembly.
   B. Shop Drawings: Submit Shop Drawings coordinated with each Termite Control Manufacturer’s systems for each type of detail required for the Project and as required to maintain each system as a complete barrier. Coordinate designated materials used on Drawings with submitted Product Data so that University knows each type of materials being used in each stainless steel screen assembly.
   C. Quality Assurance Submittals: Refer to “Quality Assurance” paragraphs herein.
1.03  QUALITY ASSURANCE:

A.  Manufacturer Qualifications:

1.  Manufacturing Experience:  Comply with Division 1 requirements.

2.  System Design Responsibility:  SS Barrier Screen Barrier Manufacturer to submit Project specific design criteria for all parts of work for which they are responsible to ensure proper performance of installed work.

B.  Installer:

1.  Licensure:  Licensed Pest Control Operator in jurisdictional location where the Project resides.

2.  Manufacturer Certification:  Submit Manufacturer’s certification that Company is an Authorized Installer of systems of types applicable to Project.

3.  Personnel Certification:  Submit list of Manufacturer trained and certified personnel.  Do not use any personnel not on required submitted lists; unless written evidence is provided that any newly assigned personnel has had the proper training.

C.  Coordination:

1.  Typical:  Each Termite Barrier Manufacturer to coordinate requirements of work with each other and with work of other Trades affecting installation of their systems; in timely manner as to assure proper installation of their systems.

2.  Level of Concealment:

   a.  Public Areas:  All exposed to view work in public areas are to be fully concealed from view.

   b.  Non-Public Areas:  Work in non-public areas, e.g. spaces used only by maintenance personnel, may be exposed to view as long as the installed systems are designed to prevent its damage.

1.04  WARRANTY:

A.  Manufacturer Warrantees:  Submit SS Barrier System Manufacturer’s “Manufacturing Defects” Systems Warranty for a period of ten (10) years and covering at minimum defects up to a maximum of $50,000 for this Project.

B.  Installer Warranty:  Submit Installer’s “Installation Defects” Systems Warranty for a period of five (5) years.
C. Warranty Conditions:

1. Start of Period of Coverage: Date certified by the University for Acceptance of the Project.

2. Surety: The Surety is not liable beyond two (2) years from the Project Acceptance.

PART 2 – PRODUCTS

2.01 STAINLESS STEEL SCREEN TERMITE BARRIER SYSTEM MATERIALS:


B. System: Provide a full system including primary Type 316 alloy stainless steel screen mesh and all related materials, e.g. stainless steel mesh, parging and stainless steel collars, as published in their current standard literature and installation instructions.

PART 3 – EXECUTION

3.01 INSTALLATION:

A. General: Comply in strict accordance with requirements fully submitted and successfully reviewed by the University.

B. Concealment: Conceal all work. No work to be exposed to view. If any conditions would expose the work to view, notify the University prior to the construction of any such affected work, prior to the construction of all adjacent work to which SS Barrier work would be attached and prior to purchase and manufacture of any materials for the Project; so that such conditions can be resolved in a manner that is acceptable to the University and in manner that additional costs are not added to the Contract Sum.

3.02 DEFECTS, PROTECTIONS & CLEANING:

A. General: Refer to Division 1 requirements.
TECHNICAL SPECIFICATIONS
Concrete Formwork

Project No. SW-12-6238

SECTION 03100 – CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SUMMARY:

A. Work Includes:
   1. Forms for all concrete, shoring and bracing, setting and embedded items, removal of forms, and forming accessories and form coating.

B. Related Work Described Elsewhere:
   1. Section 03200 - CONCRETE REINFORCEMENT
   2. Section 03300 - CAST-IN-PLACE CONCRETE

1.02 REFERENCES:

A. ACI: Recommended Practice for Concrete Formwork.
B. ACI: Building Code Requirements for Reinforced Concrete.
C. WCLIB: Standard Grading Rules
E. PS-1: Construction and Industrial Plywood

1.03 COORDINATION:

A. All pipe sleeves, anchors and bolts, including those for angle frames, insert supports, ties and other material in connection with concrete construction shall be secured in position before the concrete is placed.

B. Obtain information and instructions from other trades and suppliers in ample time to schedule and coordinate the installation of items furnished by them to be embedded in concrete so that provisions for their work can be made without delaying the project.

1.04 PRODUCT HANDLING:

A. Protection: Protect from work materials before, during and after installation and protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Architect at no additional cost to the Owner.
PART 2 – PRODUCTS

2.01 EARTH FORMS:

A. Unless otherwise indicated or required by the Structural Drawings, concrete for grade beams, footings and similar below grade structures may be placed directly against vertical excavated surfaces provided that minimum reinforcing steel clearances of 3-inches shall be maintained.

B. Take suitable provisions to prevent raveling of top edges or sloughing of loose material from walls of excavation and make all excavations with a neat cut.

C. Concrete which is exposed to view on the exterior shall be formed to a minimum depth of 6-inches below finished grade.

2.02 WOOD FORMS:

A. Exposed concrete not otherwise noted or specified: DFPA graded HDO (High Density Overlaid) Plyform, Class I or II (as per strength and tolerance requirements), exterior, each piece grade marked.

B. Unexposed Concrete, not otherwise specified: Of sufficient design and strength to hold concrete properly in place and in alignment.

C. Framing: Optional subject to meeting necessary strengths and surface tolerances

D. Joints in Exposed Concrete Walls: Minimize the number of horizontal joints by using the longest lengths of plywood practical.

2.03 OTHER MATERIALS:

A. Form Release Agents: Type which will not stain the concrete or interfere with future applied coatings and finishes: See Division 7 and Division 9.

B. All other materials not specifically described but required for proper completion of concrete formwork, shall be as selected by the Contractor subject to the acceptance of the Architect.

PART 3 – EXECUTION

3.01 GENERAL:

A. Construct forms specified for the purpose, rigidly constructed and providing for special built-in features and details, as indicated.
3.02 FORM WORK DESIGN:

A. Design all forms to resist spreading, shifting, settling, and deflecting more than 1/8-inch between supports after the placement of concrete. Accurately procure the required lines, grades and surfaces within the specified tolerances.

B. Design all forms and shoring to prevent leakage and washing out of cement mortar.

3.03 CONSTRUCTION OF FORMS:

A. Rigidly support and substantially construct forms; erect plumb, straight and true to line, shape for removal without prying against the concrete. Make forms tight without cracks or holes so as to prevent loss of fine particles from the concrete.

B. Form Sealer: Apply form sealer to forms prior to placing reinforcement. Apply in strict conformance with latest printed recommendations of the sealer manufacturer. See Article 2.5.

3.04 EMBEDDED ITEMS:

A. Conduit in Slabs on Grade: Do not embed piping or electrical conduit in structural concrete unless specifically approved in writing by the Structural Drawings.

B. Anchors and Rough Hardware: These consist of bolts, inserts, and other items required to be embedded in formed concrete. Accurately secure them so that they will not be displaced during concrete placement and finishing. Verify the size, length, and location of anchor bolts with respect to equipment supports.

3.05 TOLERANCES:

A. All form work shall be set accurately to produce designated elevations and contours of the finished surface and shall be true, straight, level and plumb. Dimensionally incorrect or improperly formed concrete work will be removed and replaced at Contractor’s expense.

3.06 REMOVAL OF FORMS:

A. The removal of forms and false work shall be carried out in such a manner as to ensure the complete safety of the structure. Supports shall not be removed until members have sufficient strength to safely support their own weight and any superimposed loading with proper factors for safety. Minimum lapsed time from concrete pour as follows:

1. Footing and slab side form: 24 hours
B. Forms for exposed concrete surfaces shall be removed in such a manner as to preclude damage to the finish. Pinch bars and similar tools shall not be used for prying against exposed surfaces.

C. Upon removal of forms, all bolts, wires, clamps, rods, etc., not necessary to the work, shall be removed to a minimum of 1-inch from the surface. Work shall be conducted as to eliminate any hanger of rust stains from form tie materials or other unprotected ferrous materials embedded in or adjacent to exposed concrete surfaces.

3.07 RE-USE OF FORMS:

A. Clean and repair the surfaces of forms that are to be re-used, except that split, frayed, delaminated or otherwise damaged form shall not be re-used. Apply new form coating materials to all contact surfaces. When forms are extended for successive concrete placement thoroughly clean surfaces and remove fines and laitance.

3.08 CLEAN UP:

A. During the progress of the Work, the premises shall be kept free from debris and waste materials resulting from the work of this Section. Upon completion, all surplus materials and debris shall be removed from the site.

END OF SECTION
SECTION 03150 – CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Detailing accessories.
      2. For construction joints.
      3. For isolation joints.
      4. For control joints.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 3 –Concrete Formwork.
      3. Division 3 –Cast-In-Place Concrete.
      4. Division 3 –Precast Concrete Specialties.
      5. Division 7 –Joint Sealers.

1.03 DEFINITIONS:
   A. Concrete Work: Unless otherwise defined, concrete work to include all concrete work, including cast and precast work.
   B. Expansion Joints: Thermal affected, isolation joints in concrete work for relief of thermal effects to concrete work. Definition of “expansion joints” includes expansion and contraction of such joints.
   C. Isolation Joints: Joints in concrete work to isolate any concrete work from adjacent work which would otherwise transfer unwanted stresses and unwanted movement from adjacent work to concrete work, e.g. adjacent vertical walls, columns and penetrations. Typical causes of isolation include movement in adjacent work due to gravity, seismic and vibratory effects.
   D. Control Joints: Joints in concrete to control shrinkage contraction in concrete slabs. Also, known as contraction joints.
E. **Construction Joints**: Pre-determined, stopping places between adjacent abutting, pours of concrete work in the same plane. Also known as “cold joints”. These joints may coincide and be used as control joints for slabs.

F. **Moving Joints**: Expansion and isolation joints.

G. **Non-moving Joints**: Control and construction joints.

1.04 **SUBMITTALS**:

A. **Product Data**: Submit for materials specified herein.

B. **Shop Drawings**: Show all joint locations and joint details for concrete work coordinated with Division 3 – Cast-In-Place Section Shop Drawings.

1.05 **QUALITY ASSURANCE**:

A. **Coordination**: Coordinate with Division 3 – Cast-In-Place Concrete Section work.

B. **Standards**: Comply with applicable ACI standards.

C. **Rustication Details**:

1. **General**: Provide as indicated.

2. **Construction Joints**: For above grade formed concrete work, where construction joints are not scheduled for subsequent finishes that fully conceal from view construction joints in finished work, e.g. wood, tile, stone, plastering and GFRP work, provide rustication detailing in accordance with Architect’s design intent as shown or where not shown as verified prior to construction of such joints.

PART 2 - PRODUCTS

2.01 **DETAILING MATERIALS**:

A. **Types**:

1. **Chamfer Strips**: Triangular shaped of 1/2" x 1/2" or 3/4" x 3/4" size, unless radius corner indicated.

2. **Rustication Strips**: Trapezoidal shape.

3. **Drip Strips**: 1/2 round or oval strips producing 1/2" or 3/4" width drips.

B. **Primary Characteristics**:

1. **Material**: Premanufactured wood, metal, plastic or rubber.
2. **Size:** As indicated. Where not indicated verify from Architect and include impacts in Bid.

2.02 **EXPANSION JOINT MATERIALS:**
   
   A. **Product:** Premanufactured product designed for forming expansion joints of each size required.

2.03 **CONSTRUCTION JOINT MATERIALS:**
   
   A. **Bentonite Strips:** Volclay “Waterstop-RX”, 3/4” x 1” or pre-approved equal.

2.04 **ISOLATION JOINT MATERIALS:**
   
   A. **Products:** One of following.
      
      1. W.R. Meadows “Ceramar”.
      
      2. W.R. Meadows “Cork”.
      
      3. Preapproved equal products of same composition to those above.

   B. **Primary Characteristics:**
      
      1. **Size:** 1/4” thickness minimum, except as follows.
         
         a. **Isolation Joints:** 1/2” for vehicular loaded applications.
         
         b. **Part of Expansion Joint Assembly:** Same thickness as expansion joint.

      2. **Flexible Foam Types:** ASTM D 5249, Type 2.

      3. **Cork Types:** ASTM D 1752, Type I.

2.05 **CONTROL JOINT MATERIALS:**
   
   C. **Non-Moving Joint Filler:** Sawcut joint or preformed with premanufactured plastic or hardboard material.

2.06 **RELATED MATERIALS:**
   
   A. **Release Materials:** If required by Product Manufacturer for “Detailing Materials”, provide Manufacturer’s approved materials that are not detrimental in any way to Project concrete characteristics.

   B. **Joint Sealant Materials:** Refer to Division 7 – Joint Sealer Section.
PART 3 - EXECUTION

3.01 INSTALLATION:
   A. General: ACI requirements that comply with each Product Manufacturer’s Project specific requirements as fully submitted and successfully reviewed by University.
   B. Joint Size and Location: Provide in accordance with ACI requirements, unless other ACI compliant joint requirements are shown.

3.02 DETAILING MATERIALS:
   A. Chamfers: Apply at outside corners of exposed formed, concrete work.
   B. Rustication Strips: Provide in field of exposed formed, concrete work if any, indicated.
   C. Drips: At bottoms of elevated, exterior, water shedding, formed concrete surfaces, e.g. soffits and at head and sills of openings or other similar conditions, that could otherwise cause water to travel sideways onto adjacent work rather than shedding water off of the end of water shedding face.

3.03 EXPANSION JOINTS:
   A. General: Install premanufactured joint forming product over isolation joint material. Remove joint forming cap and seal with joint filler and sealant.

3.04 CONSTRUCTION JOINTS:
   A. Bentonite Watetstop: For all construction joints in concrete structures, unless otherwise acceptable to University.

3.05 ISOLATION JOINTS:
   A. General:
      1. Isolation: Isolate all concrete slab work of any type where one type abuts another or where concrete work abuts other construction.
      2. Filler Size: Full joint width by full joint depth less depth required for proper exposed joint sealant performance.
   B. Expansion Joint: Coordinate work with expansion forming product for joint filler and sealant required for each expansion joint. Install isolation joint material full depth and width below expansion joint.
      1. Construction Joints: Tool each side of joint at concrete edge with continuous 1/8” radius. Refer to Structural Drawings for load transferring dowels or other detailing as required for each joint.
3.06 **CONTROL JOINTS:**

A. **General:** Locate in accordance with ACI requirements. Control joints can be coincided with contraction joints when accordance with ACI requirements.

3.07 **RELATED MATERIALS:**

A. **Joint Sealant:** Seal all expansion, isolation and control joints in accordance with Division 7 – Joint Sealers Section.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY:
A. Work Includes:
   1. Fabricate, furnish and install reinforcing steel for concrete work including dowels in concrete for masonry work.
   2. Accessory items such as chairs, tie, wire, etc.
   3. Reinforcing steel for concrete work.
B. Related Work Described Elsewhere:
   1. Section 03100 – CONCRETE FORMWORK.
   2. Section 03300 – CAST-IN-PLACE CONCRETE.
   3. Section 04220 – CONCRETE MASONRY UNIT.

1.02 QUALITY ASSURANCE:
A. Qualifications for Workmen: Provide at least one person who shall be present at all times during execution of this Work and who shall be thoroughly familiar with the type of materials being installed and the best methods for their installation and who shall direct all other work performed under this Section.
B. Conflicting Standards: Where provisions of pertinent codes and standards conflict with the specification, the more stringent provisions shall govern.
C. Special Inspection:
   1. The Owner's Special Inspector will inspect the work in a timely manner in accordance with IBC 2006, Section 1704, and 2nd Edition of "Special Inspection Recommended Standard of Practice" by the Structural Engineers Association of Hawaii.
   2. The Special Inspector will be specifically accepted as qualified by City and County of Honolulu Building Department.
   3. The Special Inspector will report to the Structural Engineer and will make daily written inspection reports which will be submitted weekly to the Owner, Architect, Structural Engineer, and Contractor.
4. Contractor shall be responsible for providing to the Special inspector, updated construction documents and schedule.

D. Submittals:

1. Submit under provisions of Section 01330 - SUBMITTAL PROCEDURES.

2. Submit bar drawings, schedules and placing diagrams for all reinforcing steel before beginning fabrication or delivery of materials to the building site. Include reinforcement at openings. Show top layer bars on a separate diagram from bottom layer bars. For walls, provide details in plan showing bar placement layout and dowel layout.

3. Submit mill reports of testing laboratory reports for all reinforcing steel to be used on the Project.

1.03 CODES AND STANDARDS:


B. ACI 318 - Building Code Requirements for Reinforced Concrete.


D. Concrete Reinforcing Steel Institute – Placing Reinforcing Bars.

1.04 PRODUCT HANDLING:

A. Bundle reinforcement and tag with suitable identification to facilitate sorting, placing and transport. Store at the site in such a way as to prevent damage to the material. Keep sufficient supply of tested and approved reinforcement on the site to avoid delaying the work.

B. Take all means necessary to protect reinforcing steel before, during and after installation and to protect the work and materials of all other trades.

C. Store reinforcing steel in a manner to prevent excessive rusting and fouling with dirt, grease or other bond-breaking coatings.

D. Take all necessary precautions to maintain identification after the bundles of reinforcing steel have been broken.

E. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Architect and at no additional cost to the Owner.
PART 2 - PRODUCTS

2.01 REINFORCING STEEL:

A. **Reinforcing Bar**: ASTM A615, deformed, new free of loose rust, and as follows:
   
   1. Provide Grade 60 bars except where otherwise shown.
   
   2. Provide Grade 75 bars where indicated.

B. **Steel Wire**: ASTM-A82, plain, cold-drawn steel.

C. **Welded Wire Fabric**: Galvanized in flat sections not rolled, ASTM A185 (fy - 65,000 psi).

D. Provide metal accessories such as spacers, chairs, ties, and other devices necessary for properly placing, supporting and fastening reinforcement in place. Used galvanized chairs. Use annealed steel wire, not less than 16 ga., to secure reinforcement. Where support legs are in contact with forms for exposed to view concrete, use supports with plastic coated legs (CRST Class I), or formed of stainless steel (CRSI Class Z). At concrete on-grade, use concrete blocks equal in strength to the structural concrete.

2.02 FABRICATION:

A. Comply will details on the drawing.

B. Where specific details are not shown or noted, do all detailing and fabrication in conformance with the requirements contained in the References, Codes and Standard Articles.

C. Clean bars of loose rust, loose scale and any substance which may decrease bond. Bend bars cold and accurately.

2.03 OTHER MATERIALS:

A. **Form Release Agents**: Type which will not stain the concrete or interfere with future applied coatings and finishes: See Division 7 and Division 9.

B. All other materials, not specifically described but required for proper completion of concrete reinforcement, shall be as selected by the Contractor subject to the acceptance of the Architect and Owner.
PART 3 – EXECUTION

3.01 SURFACE CONDITION:

A. Carefully inspect the installed work of all other trades prior to installing reinforcing steel and verify that all such work is complete to the point where work may commence.

B. Verify that reinforcing steel is installed in strict accordance with all pertinent codes and regulations and the original design.

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.

D. Clean reinforcement of loose mill scale, oil, or other coating that might destroy or reduce the bond before it is placed.

3.02 PLACING:

A. Reinforcing steel shall be placed in accordance with the Drawings and reviewed shop drawings and the applicable References, Codes and Standard Articles. Install reinforcement accurately and secure against movement, particularly under the weight of workmen and the placement of concrete.

B. Reinforcement Supports: Reinforcement shall be accurately located in the forms and held in place by means of supports adequate to prevent displacement and to maintain reinforcement at a proper distance from form face. Supports and their placement shall comply with CRSI Placing Reinforcing Bars. The use of wood, brick or rock supports and spacers inside the forms is not permitted.

C. Support reinforcement for slabs on grade by wiring to precast concrete blocks or chairs spaced 32-inches o.c. maximum both ways. Size blocks or chairs so that reinforcing is maintained as detailed on drawings. Reinforcing lying on ground during concrete placement will not be acceptable.

D. Obstructions: Wherever conduits, piping, inserts, sleeves, etc., interfere with the placement of reinforcing steel, obtain the Architect's approval of a method of procedure before and after concrete is placed. Bending the bars around openings or sleeves is not permitted.

E. Tying: All reinforcing shall be rigidly and securely tied with steel tie wire at all splices and at all crossing points and intersections in the position shown. All tie wires, after cutting, shall be bent in such a manner that concrete placement will not force the wire ends to surface out of the concrete.
F. **Splicing**: Make splices only at those locations shown on the Drawings or as approved by the Architect. Stagger splices in adjacent bars wherever possible. Standard splices shall be lapped at ends placing bars in positive contact and tightly wire tied. Lapped joints shall be 40 diameters or 2-feet minimum, unless noted otherwise on the Structural Drawings.

G. **Dowels**: Dowels shall be tied securely in place before concrete is deposited. In the event there are no bars in position to which dowels may be tied, No. 3 bars (minimum) shall be added to provide proper support and anchorage. Bending of dowels after placement of concrete will not be permitted. Expansion joint dowels shall be wrapped or greased on one side of the joint to prevent bonding.

H. Unless permitted by the Architect, reinforcement shall not be bent after being partially embedded in hardened concrete. Improperly and excessively bent bars shall be replaced.

I. Concrete protective covering for reinforcement, except for extremely corrosive atmosphere, other severe exposures, or fire protective covering shall be as follows:

1. **Concrete deposited against the ground**: 3-inches.

2. **Formed surfaces exposed to weather or in contact with the ground**: 2-inch for reinforcing bars No. 6 or larger; 1-1/2 inch for reinforcing bars less than No. 6; except not less than 1-1/2 inch times maximum size of aggregate for column spirals or ties.

3. **Interior Surfaces**: 1-1/2 inch for beams, girders, and columns; 1-inch for slabs and walls, unless noted otherwise on the drawings.

J. Make splices for welded fabric as shown on Drawings. Locate wire fabric at mid-depth of slabs if not indicated otherwise.

**3.03 CLEAN UP:**

A. During the progress of the Work, the premises shall be kept free from debris and waste resulting from the work of the Section. Upon completion, all surplus material and debris shall be removed from the site.

**3.04 ADJUSTMENT OF CONTRACT SUM:**

A. Adjustment of the Contract Sum for reinforcing steel changes made prior to fabrication from reviewed shop drawings will be based on the total net difference in rebar weight, either additive or deductive, per unit price stated in the Contract.
B. Adjustment of the Contract Sum for reinforcing steel changes made after fabrication from reviewed shop drawings will be based on the additive weight of new bars, if any, and the deductive weight of any bars which can be used elsewhere to replace bars not yet fabricated. Unused superseded steel previously fabricated will be available for timely disposition by the Owner at the job site.

END OF SECTION
 SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 WORK INCLUDED:

Cast-in-place concrete and all accessories.

1.02 RELATED SECTIONS:

A. Section 03100 - CONCRETE FORMWORK.
B. Section 3200 - CONCRETE REINFORCEMENT.

1.03 REFERENCED STANDARDS:

A. ACI 301 - Specification for Structural Concrete for Buildings.
B. ACI 304 - Recommended Practice for Measuring, Mixing and Placing Concrete.
C. ACI 309 - Recommended Practice for Consolidation of Concrete.
D. ACI 318 - Building Code Requirements for Reinforced Concrete.
E. Comply with the IBC, 2006.

1.04 SUBMITTALS:

A. Submit under provisions of Section 01330 - SUBMITTAL PROCEDURES.
B. Design Mixes: For each concrete mix. Indicate amounts of mix water to be withheld for later addition at project site.
C. Material Test Records.
D. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
   1. Form materials and form-release agents.
   2. Fiber reinforcement.
   3. Waterstops.
5. Floor and slab treatments.


7. Adhesives.

8. Vapor Barriers.


1.05 QUALITY ASSURANCE:

A. Testing laboratory as required for tests in this Section shall be approved by the Owner and shall submit the results of all tests in writing and in the required copies to the Architect.

B. The Contractor will be responsible for all testing of the mixed concrete. The Contractor shall coordinate and cooperate with the testing and inspection program.

C. **Mix Design:** Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixtures or field test data, or both, according to ACI 211.1 and ACI 301.

1. **Compressive Strength (28 days):** As indicted on Structural Drawings.

2. **Slump:** 4 inches +/- 1 inch prior to the addition of water-reducing admixtures.

3. **Maximum water-cementitious ratio:** 0.50.

D. Submit reports on proposed mix design to the parties named above for approval at least 7 days prior to the placing of any concrete. No concrete shall be allowed to be poured until mix designs have been approved. No substitutions shall be allowed in the materials used on the job without additional test reports as specified herein, showing that the quality of the concrete is satisfactory.

E. **Concrete:** The Contractor's testing laboratory shall sample and test as follows:

1. **Compression Tests:** Make 4 standard test cylinders from each day's placing and each 100 cubic yards, or fraction thereof, of each class of concrete. Date cylinders, numbers and note indicating the point from which the sample was taken. Indicate the slump test result of sample.
2. **Test Cylinders:** Make test cylinders at the job, in accordance with ASTM C131. At the end of 24 hours after making, store the cylinders under moist curing conditions, at approximately 70 degrees F, until tested. Test specimens in accordance with ASTM C39, with one cylinder at the age of 7 days and two cylinders at age 28 days. Cylinders broken to determine strength of concrete to commence pre-stressing shall be cured under field conditions.

3. **Slump:** Tests shall be in accordance with ASTM C143 and performed at the same time as the strength test cylinders are made. Slump tests shall also be made at any time the appearance of concrete indicates a change in consistency.

4. **Below Strength Concrete:** Should the strength of the concrete, as indicated by the tests, fall below the required minimum, then additional tests of concrete, which the unsatisfactory samples represented, may be required.

**F. Transit Mixed Concrete:** The manufacturer of the transit mixed concrete shall deliver a certification with each load stating the concrete mix design contained in the load.

**G. Records:** Keep a record and make available for inspection at the site, showing the date and time of placing of concrete in each portion of the structure.

**H. Special Inspection:**

1. The Owner's Special Inspector will inspect the work in a timely manner in accordance with IBC 2006, Section 1704, and 2nd Edition of "Special Inspection Recommended Standard of Practice" by the Structural Engineers Association of Hawaii.

2. The Special Inspector will be specifically certified by the Honolulu County Building Department.

3. The Special Inspector will report to the Structural Engineer and will make daily written inspection reports which will be submitted weekly to the Owner, Architect, Structural Engineer, and Contractor.

**PART 2 - PRODUCTS**

**2.01 MATERIALS:**

A. **Portland Cement:** ASTM C150, Type I or II. The brand of cement shall not be changed during the progress of the job unless approved in writing by the Architect.
B. **Standard Weight Aggregates**: ASTM C33 from approved pits. The maximum size used in a particular location shall be consistent with the form and dimension of the section being placed, with the locations and spacing of the reinforcing steel and with the method of vibration. The aggregate sizes shall be such as will produce dense, uniform concrete, free of rock pockets, honeycombs or other irregularities.

1. **Fine Aggregates**: Graded 1/4 inch to fines.
2. **Coarse Aggregates**: Graded to 3/4 inch maximum sizes hereinafter specified.

C. Place coral aggregate concrete on all exposed cast-in-place concrete wall.

D. **Water**: Clean and free of deleterious amounts of acid, alkalis, salts, oils or organic substances.

E. **Admixtures**: Except as otherwise specified, admixtures, if used, shall be supplied by one manufacturer and batted in strict accordance with the manufacturer's recommendations throughout the project. Any addition of admixture and admixture brands are subject to prior written acceptance of the Architect. Admixture used must be compatible with bonding of specified concrete finishes.

1. **Air-Extraining Admixture**: ASTM C260.
2. **Water-Reducing Admixture**: ASTM C494, Type A.
3. **High-Range Reducing Admixture**: ASTM C494, Type F.
4. **Water-Reducing and Retarding Admixture**: ASTM C494, Type D.

2.02 **CONCRETE CLASSES**:

A. All concrete shall be regular weight concrete unless otherwise noted, weighing approximately 150 per cu. ft. Contractor shall be solely responsible for the design of concrete mixes to meet all the requirements of the Specifications.

B. **Concrete Classes**:

1. **Ready-Mixed Concrete**: Compressive Strength (28 days) as indicated on Structural Drawings.
2. **Non-Shrink Grout**: Pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7000 PSI at 28 days.
2.03 MISCELLANEOUS MATERIALS AND ACCESSORIES:

A. All other materials, not specifically described but required for a complete and proper installation of the cast-in-place concrete shall be as selected by the Contractor subject to the acceptance of the Architect.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Prior to placement of concrete, examine all conditions affecting the proper installation of work of this Section and do not proceed until all unsatisfactory conditions have been corrected including the following:

1. Approval of compaction tests of fill and backfill as required by soils report. See soils report for fill beneath all concrete cast on grade.

2. Completion of the placement of drainage fills as required.

3. Completion of form work as required in the Concrete Form Work Section.

4. Placement approval by Special Inspector of reinforcement as required in the Concrete Reinforcement Section.

5. Notify the Special Inspector at least 48 hours before placing concrete. Notify the Architect and Structural Engineer 48 hours (two working days) in advance of each concrete placement.

3.02 SURFACE CONDITIONS:

A. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Verify that all items to be embedded in concrete are in place.

C. Verify that concrete may be placed to the lines and elevations indicated on the Drawings, with all required clearance from reinforcement.

D. 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.

3.03 PREPARATION:

A. Remove all mud, water, wood scraps and debris from the areas in which concrete will be placed.
B. Thoroughly clean the areas to ensure proper placement and bonding of concrete.

C. Prepare forms as specified prior to concrete placement.

D. Thoroughly clean all transporting and handling equipment.

3.04 MIXING:

A. Concrete shall be ready-mixed as per ASTM C94. All equipment shall be adequate for the purpose and kept in good mechanical condition at all times.

B. The rate of delivery, haul time, mixing time and hopper capacity shall be such that all mixed concrete delivered shall be placed in the forms within 90 minutes from the time of introduction of cement and water to the mixer. Any interruption in placing in excess of 90 minutes will be cause for shutdown of the Work for the day and the wasting of any remaining mixed concrete in hoppers or mixers. In case such interruption occurs, provide construction joints as directed and cut concrete back to such lines, cleaning forms and reinforcing as herein specified.

C. No water shall be added to the mix after the initial introduction of mixing water for the batch except when, on arrival at the job site, the slump of the concrete is less than that specified and provided that the water cement ratio of the approved mix design shall not exceed by such addition of water.

D. All concrete shall be kept continuously agitated until discharged into the hopper at the job site.

3.05 TRANSIT-MIX DELIVERY SLIPS:

A. Keep a record at the job site showing time and place of each pour of concrete, together with transit-mix delivery slip certifying contents of the pour. Delivery tickets shall show departure time from plants.

B. Make the record available to the Special Inspector and the Architect for their inspection upon request.

C. Upon completion of this portion of the Work, deliver the record and the delivery slips to the Architect.

3.06 PLACING:

A. All absorbent forms shall be thoroughly wetted down before concrete is placed. Subgrade for slabs on grade shall be moist but not saturated when concrete is placed.
B. Placing of concrete shall be done immediately after mixing. No concrete shall be placed or used after it has begun to be set and no retempering will be allowed. The method used in placing shall be such that concrete is conveyed to place and deposited without separation of the ingredients. No concrete shall be placed with a free unconfined fall in excess of 5 feet nor shall it be allowed to cascade through reinforcing steel in such manner as to promote segregation. Do not support runways on reinforcing steel.

C. Splash or accumulations of hardened or partially hardened concrete shall be removed as directed. Concrete containing piping shall be placed in a manner that will prevent damage to pipes.

D. Placing of concrete shall be carried on in a continuous operation without interruption until placing of course, section, panel or monolith is completed.

E. Distribution of concrete shall be even and continuous and no pour joints shall show. Before a pour is started, make certain that adequate equipment, men and concrete will be available to pour in cycles which will permit proper and thorough integration of each layer of concrete.

F. No concrete shall be placed for any element until all reinforcing for same is fastened in place nor until forms are complete. No concrete shall be placed before all work that is to be embedded is set. Notify other crafts so they may deliver anchors, inserts, etc., or other work to be embedded in ample time and also notify them when their assistance is required. Reinforcing or other materials that have been set shall not be disturbed.

G. No pipes or conduits shall be embedded in structural concrete unless specifically approved by the Architect prior to embedment. Before placing concrete, all pipes and large conduits that pass through a wall or slab shall be sleeved providing 1/4 inch clearance (minimum) all around. Sleeves shall be positioned so as not to impair strength of surrounding elements. Sleeves and inserts will be provided and set under other sections of the Work. Reinforce walls or slabs around sleeves as shown on drawings.

H. Verify depths of depressed slab conditions if shown for suitability with type and method of surfacing to be applied over concrete.

I. Install various inserts, anchorages, etc. required by public and private utility companies to accommodate miscellaneous metal items and equipment furnished by them.

J. Concrete and grout shall be removed from all surfaces that will receive painter’s finish.
3.07  **VIBRATION AND COMPACTION:**

A. All concrete shall be thoroughly compacted by means of internal mechanical vibrators. Such compaction shall be produced as will be obtained by placing the vibrator directly in concrete at 18 to 30 inch intervals for a period of approximately 5 to 15 seconds and withdrawing slowly or as directed, depending on the consistency of concrete. One vibrator will be required for each location where simultaneous pouring takes place, to ensure thorough vibrating of all sections at time of pour. Provide sufficient spare vibrators on the job so as to have them readily available in case any vibrator in use should suddenly cease to function properly. Under no condition shall vibrator be placed against reinforcing steel or attached to forms. Use no vibrators to transport material.

B. Vibrator shall be of flexible immersion type having a frequency of not less than 7,000 rpm.

3.08  **CONSTRUCTION JOINTS:**

A. Placement of construction joints and the manner in which they are provided for shall be only as approved by Architect or as shown on Drawings. Construction joints shall be as few as possible and will not be permitted simply to save forms. If the Contractor feels for any reason a change is required he shall submit his placing plan to the Architect for approval.

B. All construction joints including keys shall be cleaned and roughened by removing entire surface and exposing clean aggregate solidly embedded by means of sandblasting or other approved methods. Forms and reinforcing shall be cleaned of drippings, debris, etc. Just before starting of new pour, horizontal concrete surfaces shall be cleaned, dampened without leaving of cement and fine aggregate. Before grout is set, place the first lift of concrete 6 to 12 inches thick and consolidate with grout so that no variation in texture will occur in unpainted concrete surfaces. Proportions will be determined by the testing agency.

C. Control joints in concrete slabs shall be scribed while finishing and saw cut to 3/4 inch minimum depth within 8 hours of pour. Width of joint shall be 1/8 inch unless noted otherwise.

3.09  **CURING:**

A. Keep all formed concrete surfaces continuously wet both in forms and after removal of forms for at least 7 days after placing. If forms are permitted to be removed prior to expiration of curing period, exposed concrete surfaces shall be kept continuously wet by means of fog and sprays and non-staining cotton or burlap mats kept moist. Plastic sheathing is not permitted.
B. Immediately upon finishing a slab area, apply a spray-on curing compound to the finished concrete surface. Spray on compound shall not be used at concrete which receives a finish coating unless it has been adequately demonstrated not to have any adverse affects on the finish coating.

3.10 EXPANSION AND SCORE JOINTS:

A. Expansion joints shall be formed and provided at the location and intervals as shown on the plans, at all locations where concrete paving abuts buildings, curbs, or other structures.

B. Joint materials shall be placed with top edge 1/2 inch below the paved surface, and shall be securely held in place to prevent movement. Joint and other edges shall be formed in the fresh concrete using and edging tool to provide a smooth uniform impression. All edges shall be struck before and after brooming.

C. After the curing period, expansion joints shall be carefully cleaned and filled with joint compound to 1/4 inch below adjacent surface in such a manner as to avoid spoiling on the surfaces or overflow from joint.

D. Score joints shall be formed in the fresh concrete using a jointer to cut the groove so that a smooth uniform impression is obtained. All joints shall be struck before and after brooming.

3.11 LEVELING AND FINISHING:

A. Tamp slabs with a jitterbug to depress the rock, and then pushfloat with a bullfloat as necessary.

B. Take care that the wet slab meets the screeds accurately and does not rise above or lower below them.

C. Carefully provide slab depressions as required for the finishes indicated on the Drawings.

3.12 CONCRETE SURFACE REPAIRS:

A. Repair and patch defective areas with cement mortar immediately after removal of forms.

B. Cut out honeycomb, rock pockets, and voids over 1/4 inch in any dimension, down to solid concrete, but, in no case, to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water, and brush coat the area to be patched with neat cement grout.
C. Repair exposed-to-view formed concrete surfaces that contain defects that adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the Architect. Surface defects, as such, include texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with cement mortar.

D. Repair concealed formed concrete surfaces that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01 inch wide, cracks of any width and other surface deficiencies that penetrate to the reinforcement of honeycomb, rock pockets, and spalls.

E. Test uniformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.

F. Repair finished uniformed surfaces that contain defects that adversely affect the durability of the concrete. Surface defects, such as, include crazing, cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through non-reinforced sections regardless of the width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.

G. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.

H. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low area and replacing with fresh concrete.

END OF SECTION
SECTION 03350 – CONCRETE FINISHING

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Common work results for concrete finishing.
   B. Related Sections:
      1. Division 1 – Sections.
      2. Division 1 – Cutting & Patching.
      3. Division 3 – Cast-In-Place Concrete.
      4. Division 3 – Precast Concrete Specialties.
      5. Division 3 – Concrete Repair.
      7. Concrete finishes in Civil and Landscape work.

1.03 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: Submit for materials which are specified herein that are in addition to materials under Division 3 - Cast-In Place Concrete Section, and are required to achieve specified finishes herein.
   C. Quality Assurance Submittals: Refer to "Quality Assurance", and "Mixes" paragraphs herein.

1.04 QUALITY ASSURANCE:
   A. Concrete Work: Except as otherwise required to achieve specified finishes and acceptable to University, comply with Division 3 - Cast-In-Place Concrete Section.
   B. Standards: Comply with applicable ACI standards.
   C. Manufacturer and Installer Qualifications: Refer to Division 1 requirements.
D. **Product Source Control:** Refer to Division 1 requirements.

E. **Trade Coordination:**

1. **Concrete Characteristics:** Without changing the Design Intent, it is required that the concrete characteristics, such as moisture content, pH levels, finish texture, and any materials used in conjunction with the concrete work meet the requirements of other work which is to be applied to and into it and whose performance in part or whole depends upon the concrete work provided. Verify and coordinate requirements with other Installers providing such work prior to construction of each structure affecting such Installers.

2. **Submittal:** Submit documentation indicating requirements mutually agreed to. Documentation to be signed by the Concrete Installer and the affected Installer.

F. **Finish Coordination:**

1. **Subsequent Applied, Interior Flooring Products:** Submit final written agreement for concrete finishing with Installers of subsequent interior flooring products with regard to each type of finishing required, required tolerances and responsibilities of the Concrete Finishing Installer and the Installer of the subsequent applied flooring product in achieving each final concrete finish.

2. **Finishes to Match Other Exposed to View Work:** See “Mockups” paragraphs.

G. **Mockups:** Prior to start of any of following finishes, following mockups to be successfully reviewed by University.

1. **Format:** For each mockup, submit single 4’x 4’ panels of each finish; not part of actual work, unless otherwise acceptable to the University. Initial smaller samples may be provided to establish general design intent of each finish. Final samples to be full panels. Refer to Division 1 - Submittals Section requirements. Construct mockups at Project site; for review at Project site. Samples to be moved to any location desired by the University.

2. **Finishes:** Furnish field samples of following finishes; when exposed to view in final work.
   a. CF-5, matching of adjacent concrete finish.

**PART 2 - PRODUCTS**
2.01 FORM MATERIALS:

A. General: In addition to materials required to achieve finishes specified herein, comply with Division 3 - Cast-In-Place Section.

B. Form Coatings: Commercial formulation form-coatings. Formulation shall not bond with, stain, nor adversely affect concrete surfaces, and shall not impair subsequent treatments of the concrete surfaces.

2.02 CONCRETE MATERIALS:

A. General: In addition to materials required to achieve finishes specified herein, comply with Division 3 - Cast-In-Place Concrete Section.

2.03 RELATED MATERIALS:

A. Curing: Refer to Division 3 – Cast-In-Place Concrete Section.

2.04 MIXES:

A. General: Comply with Division 3 - Cast-In-Place Concrete Section.

PART 3 - EXECUTION

3.01 FINISH OF FORMED SURFACES:

A. Tolerances – General: ACI 117.

B. CF-1, Rough Formed Finish:

1. General: For formed concrete surfaces not exposed-to-view in final finished and in-place work, unless otherwise indicated.

2. Finish Quality: ACI 347R, Class B.

C. CF-2, Smooth Form Finish:

1. General: For a concrete surface exposed-to-view in final in-place work; which is to be left unfinished, subsequent CF-3 finished, and finished with penetrating clear water repellent, including architectural precast work.

2. Finish Quality: ACI 347R, Class A; repaired and patched defective areas with fins or other projections completely removed and smoothed.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final
surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.02 **MONOLITHIC SLAB FINISHES:**

A. **Intent:** Paragraph 3.02 and subsequent related paragraphs apply to applies to the Work as follows.

1. To new concrete slabs.

2. “F” numbers to apply where existing slabs do not meet the specified tolerances. Where the existing slabs do not meet the Project tolerances, then the concrete surfaces are to repaired in accordance with Division 3 – Concrete Repair Section to meet the required tolerances.

B. **Minimum Standards:** ACI 302.1R.

C. **Floor Flatness Standard:** ASTM E 1155, with "F" number requirements as specified herein.

D. **CF-3, Float Finish:**

1. **Location:**
   a. Apply to surfaces to receive subsequent CF-4 trowel finish.
   b. Where this is required by any Installer of a subsequent flooring product and is in compliance with CF-8 requirements.

2. **Installation:** After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of poser driven floats, or both. Consolidate surface with power driven floats, or by hand floating if area is small or inaccessible to power units. Uniformly slope surfaces to drains. Cut down high spots and fill low spots. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

3. **Tolerance:** $F_F \leq 18 - F_L \geq 15$.

E. **CF-4, Trowel Finish:**

1. **Location:** Apply to the following.
   a. Prior to applying the texture for the CF-7 finish.
   b. Where this is required by any Installer of a subsequent flooring product and is in compliance with CF-8 requirements.
   c. If any surface not otherwise covered by another specified CF-# finish.
2. **Installation:** After floating, begin first trowel finish operation using a power driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand troweling operation, free of trowel marks, uniform in texture and appearance. Grind smooth surface defects which would telegraph through any applied floor covering materials.

3. **Tolerances:**
   
a. **On-Grade:**  \( F_F \ 35 – F_L \ 25; \) with \( F_F \ 24 – F_L \ 17 \) min. local values.

F. **CF-5, Matching of Adjacent Concrete Finish:**

1. **Location:** Apply to following and as otherwise indicated.
   
a. Finish of new exterior slabs. If more than one adjacent concrete finish, verify which finish is to be matched.

2. **Installation:** Apply CF-4 trowel finish as specified herein, then immediately follow with implement or materials necessary to match the adjacent concrete finish.

3. **Profile, Texture, and Pattern:** Ensure profile, texture and any directional pattern is in accordance with the University’s requirements.

G. **CF-6, Finish for Subsequent Applied Flooring Products:**

1. **Location:** For interior slabs scheduled to receive subsequent final floor finishes, e.g. resilient flooring, epoxy-quartz flooring and any other subsequent finishes that depend on the quality of the concrete finish for its performance.

2. **Installation:** Verify each affected Subsequent Finish Product Manufacturer's Project specific requirements from the Installer of each product and provide the final slab finish in strict accordance with each affected Product Manufacturer's requirements, unless each Installer of such subsequent finish products submits a written confirmation that subsequent concrete finish, e.g. scarification or other, will be provided by them.

3. **Tolerances:** Not less than CF-4 tolerances, unless a higher or lesser quality tolerance is approved in writing by the Installer of the subsequent flooring product.

3.03 **EXISTING FORMED & SLAB FINISHES:**

A. **CF-7, Preparation of Existing Concrete Surfaces:**

1. **Exposed Formed Concrete:** If any, clean surfaces of deleterious materials. Patch and level surfaces. Apply CF-3 finish.
2. **Exposed Formed Concrete – Scheduled for Subsequent Finish:** Prepare work in strict conformance with each subsequent Product Manufacturer’s Project specific requirements as verified from the Installer of the subsequent product.

3. **Exposed Slab Surfaces:** Patch and level each surface as required to meet Project specified tolerances.

4. **Exposed Slab Surfaces – Scheduled for Subsequent Finish:** Prepare work in strict conformance with each subsequent Product Manufacturer’s Project specific requirements as verified from the Installer of the subsequent product.

3.04 **CONCRETE SURFACE REPAIRS:**

A. **Non-Structural Defects:** Repair following types of defects.

1. **Exposed-to-View Surfaces:**

   a. **Cracks:** Repair all cracks which affect durability of concrete. Fill all cracks.

   b. **Voids:** Repair all spalls, air bubbles, honeycomb, rock pockets, bug holes, tie holes, and other voids in excess of a pinhole (1/16”).

   c. **Projections:** Remove fins and other projections from surface.

   d. **Color/Texture Irregularities:** Remove stains and other discolorations.

   e. **High Areas on Slabs:** Correct surfaces by grinding, after concrete has cured at least 14 days.

   f. **Low Areas on Slabs:** Correct surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to University.

2. **Concealed Surfaces:** Repair defects that affect the durability of concrete. If defects cannot be repaired, remove and replace with new concrete. Where waterproofing materials are indicated, remove projections and defects necessary for proper waterproofing of surface in conformance with instructions of Waterproofing Manufacturer.

B. **Non-Structural Repairs:** Utilize polymer reinforced mortar patching materials in strict accordance with Material Manufacturer’s requirements. Provide appropriate aggregate sizes for depth of area to be repaired. Finish smooth to blend with adjacent surfaces.
C. **Structural Repairs:** Perform structural repairs with prior approval of University for method and procedure, using specified epoxy adhesive and mortar.

D. **Color/Texture Repair:** Even out color/texture appearance of all exposed-to-view formed surfaces with a wash finish where not required to be opaque painted or where irregularities can telegraph through final finishes.

END OF SECTION
SECTION 03480 – PRECAST CONCRETE SPECIALTIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Ornamental precast specialty products.
      2. Functional precast specialty products.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 3 – Cast-In-Place Concrete.

1.03 DEFINITIONS:
   A. Precast Ornamental Specialties: Precast concrete units whose primary purpose is aesthetic and therefore appear more ornamental or sculpted. These products are typically window sills, wall caps, balustrades, finials, columns, piers, pedestals, free standing planters, sculptures, and other similar ornamental elements.
   B. Precast Functional Specialties: Precast concrete units whose primary purpose is functional rather than aesthetic and more plain in look than its ornamental counterpart.

1.04 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: Submit data on products.
   C. Shop Drawings: Submit plan drawings showing locations of each required product.
   D. Samples: For each product type, submit samples of actual products, if requested, by University.

1.05 QUALITY ASSURANCE:
   A. Product Source Control: Refer to Division 1 requirements.
B. **Precast Specialty Manufacturer Qualifications:** Eight (8) years minimum, continuous and current experience in producing precast specialties of types and for Project of similar scope and installation complexity as required for this; satisfactory to University.

C. **Coordination:** Coordinate with other trades, requirements necessary for proper installation of each precast product.

D. **Precast Standard:** Products and fabrication methods to comply with Precast Concrete Institute (PCI) Standards PCI MNL-117 and PCI Design Manual applicable to the production of Architectural precast products of types required herein.

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**PART 2 - PRODUCTS**

2.01 **CONCRETE MATERIALS – GENERAL:**

A. **Primary Concrete Materials:**

1. **Portland Cement:** ASTM C 150, Type I or Type III as standard for each product and complying with color as follows.
   a. **Precast Ornamental Specialties:**
      1) **Scheduled for Paint Finish:** Gray cement.
      2) **Other:** White cement.
   b. **Precast Functional Specialties:** Gray cement.

2. **Aggregate:** ASTM C 33 coarse and fine aggregate; standard for product; except aggregate not to contain any ferrous materials. Types as follows.
   a. **Precast Ornamental Specialties:** White colored aggregates standard with Manufacturer.
   b. **Precast Functional Specialties:** Basalt coarse aggregate and sand or other standard aggregate types acceptable to the University.

3. **Water:** Non-deleterious to each concrete mix.

4. **Admixtures:** If required or standard with Manufacturer, comply with following.
   a. **Integral Color:** ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
Color to be selected by the University from Manufacturer’s standards for product line.

b. **Air-Entraining**: ASTM C 260.

c. **Water-Reducing, Retarding, or Accelerating**: ASTM C 494; containing 0.1% maximum chloride ions.

5. **Mix**: 28 day, minimum compressive strengths as follows.
a. **Precast Ornamental Specialties**: 6000 psi or as otherwise pre-approved by University.
b. **Precast Functional Specialties**: Not applicable.

B. **Reinforcement**:

1. **Deformed Reinforcement Bars**:
a. **Standard**: ASTM A 615, Grade 60 minimum; deformed.
b. **Galvanized**: ASTM A 767, Class II, hot dipped galvanized after fabrication and bending.
c. **Epoxy Coated**: ASTM A 775.


2.02 **RELATED MATERIALS**:

A. **Mortar**:

1. **Standard**: ASTM C 270.

2. **Materials**:
a. **Portland Cement**: ASTM C 150, Type I.
b. **Hydrated Lime**: ASTM C 207, Type S.
c. **Aggregate**: ASTM C 144, sand without ferrous materials.
d. **Pigment**: If required to set colored product, use same product used in product required to be mortarset and matched to product.

3. **Mortar Type**: Type N or S.

4. **Mix**: Proportion method based on specified standard.

5. **Form**: Field mix or ready mix may be used.
B. **Anchorage Devices:** As required for proper support of each work and complying with following.

1. **Pre-manufactured Anchors:**
   a. **Material:** AISI Type 304 or 316 stainless steel.
   b. **Products:** Selected products from one of following.
      1) Dur-O-Wal; Div. of Dayton Superior.
      2) Heckman Products, Inc.
      3) Hohman & Barnard.
      4) Or pre-approved equal.

2. **Fasteners:** AISI Type 300 series alloy fasteners.

C. **Water Repellent:** Manufacturer selected; complying with following.

1. **Generic Type:** Penetrating silane product.
2. **Absorption:** ASTM C 642, 90% minimum reduction; after 24 hours.
3. **Water Vapor Transmission:** ASTM E 96 and ASTM D 1653, 80% minimum as compared to untreated samples.
4. **Color Change to Applied Project Substrate:** No change.
5. **Compatibility:** Improves or does not reduce bonding capability of subsequent scheduled Project paint coatings.

2.04 **PRECAST ORNAMENTAL SPECIALTIES - FABRICATION:**

A **Specified Products:** Comply with each Product Manufacturer’s standard fabrication requirements as applicable to each product and as successfully reviewed by University in complete submittals.

B **Custom Products:**

1. **For:** Precast caps, sills, precast planter curbs and similar custom cast products to meet Project requirements.
2. **Size and Configuration:** As indicated. Single length, except running lengths of equal smaller units as approved by University.
3. **Casting Method:** Wet or dry cast products.
4. **Finish:** Smooth cement wash finished surface.
5. **Sealing:** Water repellent sealed.
2.05 PRECAST FUNCTIONAL SPECIALTIES - FABRICATION:

A. Splash Blocks - Units: Concrete gray, precast units of nominal 12" width x 16" depth x 4" height and a depressed gutter of approximately 2" with slope to front edge or comparable configuration acceptable to the University.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General: Install products in accordance with each Product Manufacturer's Project specific requirements as fully submitted and successfully reviewed by University.

B. Precast Ornamental Specialties: Install precast sills and caps where indicated on Drawings.

C. Precast Functional Specialties:

1. Splash Blocks: One at each downspout termination where water spills to adjacent surface.

3.01 DEFECTIVE WORK, CLEANING & PROTECTION:

A. General: Refer to Division 1 requirements.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Preparation and cleaning of existing concrete work.
      2. Nonstructural concrete and masonry patching.
      3. Leveling materials.
   B. Related Sections:
      1. Division 1 – Sections.
      2. Division 3 – Cast-In-Place Concrete.
      3. Division 3 – Concrete Finishing.

1.03 SYSTEM DESCRIPTION-DESIGN INTENT:
   A. Preparation of Existing Concrete Work:
      1. Prepare existing concrete work to ensure success of subsequent scheduled finishes.
      2. Patch all defective concrete, e.g. spalls, moving and non-moving cracks, broken concrete and other damages.
   B. Appearance: For exposed to view work, patching to be blended with adjacent work to minimize its appearance in final finished work.
   C. Materials:
      1. For: Patching and leveling of concrete and masonry surfaces.
      2. Type: Resin modified portland cement based designed for each application required; no gypsum based materials are to be used. Resin modifier to be non-re-emulsifiable when exposed to moisture and water; even under full, long term immersion.
      3. Thickness: For application, selected materials to be capable of featheredging or being built-up to thickness of patch.
4. **Performance**: Materials to be not less in compressive, flexural, and tensile strength than materials being patched or leveled, but not less than 5000 psi 28 day strength.

D. **Bonding Adhesives**:

1. **For**: To improve bonding between patching materials and substrate.
2. **Type**: ASTM C 881, epoxy resin adhesive.
3. **Viscosity**: As required for application.
4. **Bond Strength**: ASTM C 882, 1500 psi minimum, 14 day strength.
5. **Moisture Resistance**: Insensitive to.

1.04 **SUBMITTALS**: Submit following.

A. **General**: Submit in accordance with Section 01300 - SUBMITTALS.

B. **Product Data**: Submit Manufacturer’s data on material composition, tested characteristics, and installation requirements specific to Project.

1.05 **QUALITY ASSURANCE**:

A. **Preparation of Existing Surfaces**: Contractor to coordinate responsibility for preparation of existing surfaces to receive subsequent scheduled finishes with Installer of this Section and each Installer providing subsequent finishes.

B. **Leveling**: Leveling includes patching and leveling necessary to correct substrate tolerances and to level substrates for subsequent applied finishes, e.g. resilient flooring, ceramic tile and stone, and carpet.

C. **Structural Repair**: If any, secure directions from University’s Structural Consultant.

D. **Specified Materials**: Specified materials may not cover every Project condition and are for more general patching. Where specified materials is not recommended for any particular use by any Product Manufacturer, notify University. Do not purchase, manufacture any Project products, and proceed with any such work, until University provides written direction.

E. **Mockups**: Where work is exposed to view in the Work, provide typical mockups of each work for review by University, prior to purchase of any materials. Secure University’s approval of appearance of each mockup, prior to start of any related work. Mockups may be part of work; at University selected locations.
PART 2 - PRODUCTS

2.01  MANUFACTURERS:
   A. Basis of Design: Products as specified hereunder.
   B. Acceptable Products: Subject to compliance with requirements, preapproved equal products may be incorporated.

2.02  BONDING ADHESIVE:
   A. Horizontal: Unitex “Slow Set Bonding Agent” or comparable product recommended by each Primary Repair Material Manufacturer.
   B. Vertical and Overhead: Unitex “Propoxy 200” or comparable product recommended by each Primary Repair Material Manufacturer.

2.03  REPAIR MATERIALS – FOR NON-STRUCTURAL & NON-MOVING REPAIR WORK:
   A. PTCH-1: Bonded Materials Company “Bonded Propatch” with “Acryl 60”.
   B. PTCH-2: Sinak “Relay” modification of portland cement.
   C. PTCH-3: Thoro “Thorite” with “Acryl 60”.
   D. PTCH-4: Unitex “Proxy 50 or Proxy 100”.

2.04  REPAIR MATERIALS – FOR NON-STRUCTURAL & MOVING REPAIR WORK (CRACKS TO 1/2" WIDTH):
   A. PTCH-5: Unitex “Pro-Flex” products.

PART 3 - EXECUTION

3.01  PREPARATION:
   A. General: Prepare substrates in strict accordance with each Finish Manufacturer scheduled to be applied to each existing substrate.
   B. Cleaning: Remove all deleterious materials, including grinding, if necessary.
   C. Bonding Profile:
      1. General: Provide proper surface profile and depth configuration for interlocking and proper bonding performances.
      2. Thinness: Remove adjacent substrate, if required, to ensure that each material is not applied to a thickness less than required by Manufacturer.
D. **Primer:** Apply bonding adhesive to all substrates.

### 3.02 PATCHING & LEVELING MORTAR INSTALLATION:

**A. General:** Install mortar in strict accordance with Manufacturer’s requirements specific to each Project application.

**B. Thickness:** Do not exceed each Manufacturer’s minimum and maximum thickness for each lift. When allowed by Manufacturer, build up materials in recommended Manufacturer’s lift thicknesses; to required depths.

**C. Surface Finish:** Flush, level, and blend patching materials with adjacent existing surfaces.

### 3.03 SCHEDULE:

**A. PTCH-1:** For floor slab and other horizontal, concrete and masonry, general repair and leveling from 1/4” to 3/4” depth.

**B. PTCH-2:** For floor slab and other horizontal, concrete and masonry, repair where featheredging and self-leveling required.

**C. PTCH-3:** For vertical and overhead repair.

**D. PTCH-4:** For exterior re-bonding non-moving cracks in horizontal and vertical substrates.

**E. PTCH-5:** For exterior sealing and bonding, low-movement cracks in horizontal and vertical substrates.

END OF SECTION
PART 1 – GENERAL

1.01 SUMMARY:

A. Section Includes:
   1. Concrete masonry units (CMU).
   2. Reinforcing steel for CMU.
   3. Mortar and grout.
   4. Supervising the work of other sections for necessary rough-in work, embeds and anchorage.
   5. Supplementary parts and components, such as clips, fasteners, supplementary framing, and other miscellaneous accessories required for a complete installation.

B. Work installed but furnished in other Sections: Division 5 for sleeves, inserts, steel lintels, bolts, anchors and similar items furnished by other trades for installation in masonry.

C. Related Work:
   1. Division – 3 for reinforcing steel for concrete, including dowels in footings.
   2. Division – 7 for water-repellent coating on exterior brick walls.
   3. Division – 8 for hollow metal doors and frames.

D. References:
   1. NCMA TEK 53 – Design of Concrete Masonry for Crack Control.
   2. NCMA TEK 13A – Details for Building Dry Concrete Masonry Walls.
   3. ACI 530 – Building Code Requirements for Masonry Structures.
   4. ACI 530.1 – Specifications for Masonry Structures.

1.02 SYSTEM DESCRIPTION:

A. Design requirements: The applicable provisions of ACI 530.1, Specifications of Masonry Construction, govern the work of this Section.
1.03 **SUBMITTALS:**

A. **Shop drawings:** Comply with ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.

1. Submit large scale, dimensioned drawings, prepared by a Hawaii-registered professional engineer, indicating fabrication, bending, and placement of reinforcing.
   
a. Show bar schedules and diagrams of bent bars.
   
b. Submit bar drawings indicating arrangement and placing of reinforcing.

2. Provide elevation drawings of each plane to be constructed of CMU.
   
a. Show location of all accessories to be mounted on or included in CMU construction, including electrical devices, openings and control joint locations.
   
b. Include special reinforcing required for attachment to footings, for openings through CMU structures and for control joints.

3. Coordinate shop drawings with the work of other trades that are part of, or will be incorporated into, the work of this section. Indicate work to be performed by other trades, including adjacent and abutting materials to which this work is to be secured.

4. Drawings shall be complete for each specific area of Project when submitted.

B. **Samples:** Submit three 6-inch by 6-inch samples of each type of masonry unit showing full range of color and texture variations to be expected in the Work.

C. **Test reports:** Submit copies of mill reports and test data for reinforcing steel.

D. **Certificates:** Submit letter from the CMU manufacturer stating that all materials meet or exceed the specified requirements for grades, types or classes.

1.04 **QUALITY ASSURANCE:**

A. The provisions of ACI 530 govern the work of this section, except as noted.

B. **Uniformity:** Obtain each color, grade, type, composition, and variety of CMU used for the Project from the same manufacturer.
C. **Regulatory Requirements:**

1. Comply with fire resistance ratings indicated and required by the authorities having jurisdiction.

2. Provide materials, accessories and application procedures listed by UL or tested in compliance with ASTM E 119 for the type of construction shown.

D. **Mockup:**

1. Before beginning work, erect a mockup at a location on the site acceptable to the Architect to demonstrate proposed CMU construction, installation methods, coordination of the work specified in other relevant sections, accessories, features, color and texture.

2. The Architect will select mockup size and features, but in no case shall it be less than 6 feet long by 6 feet high with a 2-foot return.
   a. Use same personnel, materials and construction techniques intended to be used for the Project, including the selected cement and aggregates specified.
   b. Grout and point and sandblast mockup as specified herein.
   c. Apply water-repellent sealer to one-half of each panel. Identify coated side.

3. Architect will review the mockup to determine if the Work falls within acceptable ranges for color and texture variation, unevenness, appearance and workmanship. Final acceptance of colors will be made from mockup samples.

4. Make corrections requested by the Architect, or remove and replace mockup when corrective work is not acceptable. Repeat mockup(s) until Architect's approval is obtained.

5. Protect approved mockup, which will be used as a standard for all remaining work on the Project, until its removal is authorized. Remove mockup only after completion and final acceptance of CMU work.

6. When properly identified for future reference, and when acceptable to the Architect, the mockup may remain a part of the Work.

E. **Certifications:** Provide manufacturer's mill certificates with each shipment of reinforcing materials delivered to the jobsite certifying that material furnished complies with specified requirements.
1.05 HANDLING:

A. Delivery:

1. Comply with applicable requirements of ASTM A 700 for packaging, loading and marking reinforcing steel materials.
   a. Use metal tags indicating size, length and other markings shown on placement drawings.
   b. Maintain tags after bundles are broken.

2. Deliver mortar and grout material in labeled, undamaged bags with the maker’s name and brand distinctly marked thereon. Keep dry until used.

B. Storage: Store materials outdoors, off the ground on pallets, protected with breathing type covers.

1. Store reinforcing to prevent rusting, staining and damage, at least 3 inches off the ground.

2. Store CMU to prevent physical damage and staining. Where CMU will be stored for extended periods, place a polyethylene between the wood pallet and the CMU.

C. Handling:

1. Protect materials from excessive moisture in shipment, storage, and handling.

2. Use caution not to damage CMU that will remain exposed in the Work.

1.06 PROJECT CONDITIONS:

A. Do not begin work unless a temperature of 50 deg. F or more can be maintained without interruption, during and for 3 days after completion of masonry work.

B. Hot weather installation: Protect masonry erected when the ambient air temperature is more than 99 degrees F in the shade, and the relative humidity is less than 50 percent, from direct exposure to wind and sun for 48 hours after installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis of design is for products by Tileco Inc, or equal.
2.02 MATERIALS:

A. Reinforcing steel: ASTM A 615, grade indicated.

B. Concrete Masonry Units:

1. Provide medium weight, load-bearing units conforming to ASTM C 90, Type I weight, except for special shape units. Open-end, split face, slumped and other special shapes don't comply with ASTM C 90.
   a. Size:
      1) 4 inches nominal (width): 3-5/8 inches actual.
      2) 6 inches nominal (width): 5-5/8 inches actual.
      3) 8 inches nominal (width): 7-5/8 inches actual.
      4) 10 inches nominal (width): 9-5/8 inches actual.
      5) 12 inches nominal (width): 11-5/8 inches actual.
   b. Type: See Drawings.
   c. Color: See Drawings.
   d. Texture: See Drawings.

2. Provide special shapes such as open-end units and channel blocks, as required by job conditions.

3. CMU that will remain exposed in the Work shall have a uniform texture and color.

4. Admixtures: For CMU exposed to the elements and not painted, or otherwise covered with a finish material, manufacture with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength, as specified below.
   a. “Block Plus W-10” by Addiment Inc.
   b. “Rheopel” by Master Builders.
   c. “Dry-Block” by WR Grace & Co.

5. Provide all CMU from the same plant.

2.03 MORTAR AND GROUT:

A. Portland cement: ASTM C 150, Type I, II or III.
B. **Lime**: Hydrated, ASTM C 207, Type S.

C. **Aggregates**:
   1. **For mortar**: ASTM C 144, natural sand.
   2. **For grout**: Clean or washed gravel conforming to ASTM C 404. Modify coarse aggregate grading requirements so that not more than 5 percent passes a No. 8 sieve and 100 percent passes a 3/8-inch sieve.

D. **Admixtures**:
   1. **Admixture for grout**: As selected by the Contractor but subject to the Architect’s approval.
   2. Use admixtures as recommended by their manufacturer. Secure manufacturer or distributor initial supervision by a qualified field representative to assure proper use of admixture.

E. **Water**: Potable and fresh.

F. **Mortar pigments**: As specified by the Architect. Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes, complying with ASTM C 979. Use only pigments by one of the following with a record of satisfactory performance in masonry mortar.
   1. Bayferrox Iron Oxide Pigments by Lanxess Corp.
   2. True Tone Mortar Colors by Davis Colors.
   4. Equal.

G. **Integral water-repellent**: Use the following additive in CMU and mortar exposed to the elements as specified by the Architect.
   1. Dry-Block by WR Grace and Co.
   2. Rheopel Plus by BASF.
   3. RainBloc by ACM Chemistries, Inc.
   4. Equal.
2.04 MIXING MORTAR AND GROUT:

A. Unless otherwise indicated, mix in proportions complying with ASTM C270 for cement-lime for Type N mortar, and ASTM C476 for grout. Mortar for parge coats, use Type N.

1. Place 1/2 of water and 1/2 of sand in a mechanically-operated mortar mixer. Then add cement, lime, admixture and the remainder of sand and water.

2. Mix for at least 3 minutes after all ingredients are in the drum, but in no case less than required for a complete mix of the materials. Do not hand-mix ingredients.

3. Use admixtures in compliance with its manufacturer's printed instructions. Secure manufacturer or distributor initial supervision by a qualified field representative to assure proper use of admixture.

4. Empty the drum completely before the succeeding batch of materials is placed therein.

5. Adjust the consistency of grout so it will flow into place without segregation of ingredients. Water may be added to compensate for loss, but grout that has begun final set and becomes harsh shall not be used.

B. Retempering:

1. Mortar may be retempered with water as required to maintain high plasticity.

2. Retemper on mortarboards only by adding water within a basin formed by the mortar and reworking the mortar into the water.

3. Discard mortar and grout that are unused after 90 minutes from initial mixing time.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine conditions and measurements affecting the work of this Section at site.

B. Verify foundation is clean, rough and level. Sandblast area under the masonry if the surface contains laitance or other foreign material, or is not sufficiently rough.
C. Verify foundation elevation is such that the bed joint thickness will be between 1/4 inch and 3/4-inch. The foundation edge shall be true to line so that the masonry does not project over more than 1/4-inch.

D. Verify that dowels are in proper location prior to start of masonry work. Correct conditions detrimental to the proper and timely completion of this work before proceeding with installation.

3.02 PROTECTION:

A. Protect exposed masonry at grade from soil stains, and when concrete walks are poured, by covering walls with 6-mil thick polyethylene or other suitable non-staining material extending at least 30-inch above grade.

B. Maintain protective covering until adjacent concrete work is cured.

C. Stained units and units with chipped faces or edge damage will not be acceptable in exposed work.

3.03 PREPARATION:

A. Clean reinforcing free of loose rust, mill scale, earth and other materials that will reduce bond to mortar or grout.

B. Clean projecting dowels of loose scale, dirt, concrete or other material that will inhibit bond.

C. For bonding masonry to foundation, clean top of concrete foundation, remove laitance and expose aggregates before starting masonry construction.

D. Shores and centering: Design, erect, support, brace and maintain shoring and centering for temporary support of masonry elements.

1. Construct true to required shape, size and form, well braced and made rigid in all parts, and capable of supporting and sustaining the loads to which they are subjected.

2. Leave shores and centering in place until masonry can safely carry its own weight and the added loads of construction.

3. Brace CMU walls adequately to withstand all forces they will be subjected to during construction. Walls, other than free-standing earth retaining walls, are not designed to be self-supporting for lateral loads until attached to floor and roof elements.

3.04 INSTALLATION:

A. Reinforcing: Place reinforcing accurately at spacing shown. Support and secure vertical bars against displacement. Place horizontal reinforcement as the masonry work progresses.
1. When foundation dowels do not line up with a vertical core, do not slope more than one unit horizontal in 6 units vertical. Grout dowels into a core in vertical alignment, even when in cells adjacent to the vertical wall reinforcing.

2. Embed reinforcing completely in grout with minimum coverage indicated below.

C. **Concrete Masonry Units:**

1. Layout CMU to minimize cutting and use of odd joint size or bond.
   a. Wherever possible, use full size units. Do not use fractional parts of units where whole units can be used.
   b. Do not use fragments of units.

2. Erect masonry plumb, square, straight and true to indicated lines, position and dimensions, in level courses with joints properly aligned and within tolerances of ACI 117.
   a. Use sound, dry, clean units. Do not use units with chips, cracks, voids, discolorations and other defects that may be visible or cause staining in the finished Work.
   b. Lay-up walls in straight uniform courses in regular running bond.
   c. Form corners with standard masonry bond by overlapping units.
   d. When moving a unit after it has been once set in place, remove the unit from the wall, clean of mortar and set in fresh mortar.

3. Cut CMU accurately to fit openings for other work. Cut and patch holes in CMU neatly and accurately.
   a. Saw cut CMU to conform to adjacent construction, to maintain uniform joint widths, and to maintain indicated joint pattern.
   b. Saw cut CMU to produce straight, sharp edges without spalling or other defects.
   c. Use deep-cut, U-shaped CMU to form bond beams, and special shapes for openings and offsets, and to maintain a proper bond throughout entire length of wall.

D. **Joints:** Make mortar joints straight, clean and uniform in width.
1. Lay starting joint on foundations with full mortar coverage on bed joint. Keep area where grout occurs free from mortar so that grout will contact the foundation.

2. Unless otherwise specified or detailed, make joints 3/8-inch thick with full mortar coverage on face shells and on the webs surrounding cells to be filled.

3. Regardless of jointing specified, all jointing in masonry exposed to the weather shall be tooled, making solid, smooth, watertight compact joints.
   a. Perform tooling when mortar is partially set but still sufficiently plastic to bond. Use a tool that compacts the mortar, pressing excess mortar out of joint rather than dragging it out.
   b. Tool joints that will remain exposed in the Work slightly concave to shed water.
   c. Tool joints of masonry that will be concealed from view, covered by other materials, or that is scheduled to receive waterproofing membrane, flush with the face of the CMU.
   d. Rake out joints that are defective at the time of tooling, re-point and then tool.

4. Butter vertical head joints well for a thickness equal to the face shell of the unit and shove these joints tightly so that the mortar bonds well to both units.

5. Set lintels, capping units and bearing plates in a full bed of mortar.

6. Do not wet CMU, except that in very dry weather the contact surfaces of the CMU shall be moistened immediately before laying.

E. Grouting: Comply with IBC Section 2104 and the following:

1. Keep mortar droppings out of, or remove from the grout space before grouting. Fill all cells solid, unless otherwise indicated.

2. Vertical cells to be filled shall have vertical alignment to maintain a continuous unobstructed cell area.

3. Puddle grout and rod to encase steel and to ensure contact with masonry cells. Encase reinforcement in a minimum of 1/2-inch of grout between CMU and reinforcement.

4. Vibrate grout after initial absorption of water by the CMU, but before plasticity is lost.
5. Grout beams over opening in one continuous operation.

6. Grout bolts and anchors inserted in the wall solidly so that there is a minimum of 1-inch of grout between the bolt, the anchor and the masonry unit.

3.05 CURING:

A. After walls are constructed, do not saturate with water for curing or any other purpose, except that when atmosphere is dry, dampen surfaces with a very light fog spray for 3 days.

3.06 HOLLOW METAL FRAMES:

A. Locate frames accurately with head level, and jambs plumb and square.

B. Attach securely to floor and brace in position prior to start of masonry erection.

C. Frames are specified to be furnished with adjustable anchors. Adjust anchors to coincide with horizontal joints in masonry.

D. Fill frames solid with mortar or grout as erection progresses. Solidly grout space between hollow metal frames and masonry.

E. Provide temporary wood spreaders from jamb to jamb to ensure that jambs do not bow in or distort from straight line as frames are filled with mortar.

F. Provide temporary shores to support heads of metal frames and prevent deflection from superimposed loads during erection.

3.07 SITE TOLERANCES OF COMPLETED WORK:

A. Variation From Plumb:

1. For surfaces of columns, walls, and arrises, do not exceed 1/4-inch in 10 feet, 1/2-inch in 20 feet nor 3/4-inch in 40 feet or more.

2. For external corners, expansion joints, control Joints, and other conspicuous lines, do not exceed 1/2-inch in 20 feet nor 3/4-inch in 40 feet or more.

3. For vertical alignment of head joints, do not exceed plus or minus 1/8-inch in 10 feet nor 1/4-inch maximum.

B. Variation From Level:

1. Do not exceed 1/2-inch in 20 feet, nor 3/4-inch in 40 feet or more.
2. For top surface of bearing walls, do not exceed 1/8-inch in 10 feet, nor 1/16-inch within width of a single unit.

C. Variation of linear building line: For position shown in plan and related portion of columns, walls, and partitions, do not exceed 1/2-inch in 20-foot nor 3/4-inch in 40-feet or more.

D. Variation in cross sectional dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/16-inch nor plus 1/8-inch.

E. Variation in mortar joint thickness: All joints are assumed to be 3/8-inch nominal.
   1. Do not vary bed joint by more than plus or minus 1/8-inch, with a maximum thickness limited to 3/8-inch.
   2. Do not vary bed joint thickness from adjacent course bed joint thickness by more than 1/8-inch.
   3. Do not vary head joint thickness by more than plus or minus 1/8-inch.
   4. Do not vary head joint thickness from adjacent head joint thickness by more than 1/8-inch.
   5. Do not vary from collar joint thickness by more than minus 1/16-inch or plus 1/8-inch.

3.08 FIELD QUALITY CONTROL:

A. Site tests: The Owner may employ a testing agency to test questionable materials for compliance with specified requirements.
   1. The Owner will pay test costs, except when testing discloses the masonry work tested does not comply with these Specifications.
   2. In the event testing shows that the masonry work is deficient, re-install masonry work at no cost to the Owner.
   3. Contractor shall pay for re-testing until the masonry installation demonstrates compliance with specified requirements.

B. Site tests and inspection: Inspection by a Registered Deputy Inspector (RDI) is required and will be provided by the Owner, unless noted otherwise on the Drawings.

C. Unless otherwise indicated, the following tests will be performed:
   1. Provide masonry prism testing for masonry strength specified to be equal or greater than 2500 psi in accordance with IBC Section2105.2.2.2 and ASTM C1314.
2. For masonry strength specified to be less than 2500 psi, testing shall be of unit strength method in accordance with IBC Section2105.2.2.1.

3.09 CLEANING:

A. Upon completion of installation, immediately clean all surfaces to remove grout scum and grout stains from CMU walls and all other surfaces.

B. Remove and replace components that are damaged, loose, chipped, broken, have been stained, corroded, or that do not match adjacent surfaces or cannot be satisfactorily cleaned or repaired, as determined and directed by the Architect, at no cost to the Owner. Stained units and units with chipped faces or edge damage will not be acceptable in exposed work.

C. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

D. After completion and cleaning, sandblast walls using caution not to damage or stain adjacent surfaces. Do not saturate with water for curing or any other purpose, except when atmosphere is dry, dampen surfaces with a very light fog spray for 3 days.

1. Provide finish to match Architect's control sample.
   a. Use an abrasive grit or sand of the proper type and gradation as required to match approved sample panel.
   b. The abrasive shall not affect the color of the finished surface.

2. Perform sandblasting in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish on each surface or area of work.

3. Carefully coordinate this work so that a minimum time elapses between the blasting operations and application of the water repellent coating.

END OF SECTION
SECTION 05080 – SHOP-APPLIED FINISHES FOR METAL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Fluoropolymer paint coatings.
      2. Powder paint coatings.
      3. Anodized finishes.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 5 – Metal Fabrications - General.
      3. Division 5 – Metal Fabrications - Steel.
      4. Division 7 – Metal Wall Panels.
      5. Division 7 – Flashing & Sheet Metal.

1.03 DEFINITIONS:
   A. Shop-Applied Metal Coatings: As defined herein, refers to factory or shop, or both, applied metal finishing systems that are applied by specialized finishing equipment under enclosed and controlled environmental conditions to achieve finish performances and quality levels not possible by manual hand held equipment.

1.04 SYSTEM DESCRIPTION - FLUOROPOLYMER COATING PERFORMANCES:
   A. Standard: AAMA 2605 compliance.
   B. Performance over Warrantable Period:
      1. Paint Coating Integrity: Free from cracking, chipping and peeling.
      2. Chalking: Does not exceed following.
         a. ASTM D 4214, Method A, 5NBS units maximum.
         b. ASTM D 659, Rating of 8 maximum.
3. **Color Change:** Does not exceed ASTM D 2244 five (5.0) Hunter ΔE units over the warrantable period and when compared with a new paint coating of the same color.

C. **Gloss:** ASTM D 523 at 60°.

1.05 **SYSTEM DESCRIPTION - POWDER COATING SYSTEM PERFORMANCES:**

A. **Standard:** AAMA 2604 compliant.

B. **Primary Characteristics:**
   1. **Pencil Hardness:** ASTM D 3363, 2H minimum.
   2. **Gloss:** ASTM D 523 at 60°.

1.06 **SYSTEM DESCRIPTION - ANODIZING:**

A. **Standard:** AAMA 611.
   1. **Exterior:** Not required.
   2. **Interior:** Class II.

1.07 **SUBMITTALS:**

A. **General:** Submit in accordance with each Section affected by requirements specified herein.

B. **Product Data - Fluoropolymer Paint Coatings:**
   1. **General:** Submit data from each Manufacturer whose products require fluoropolymer paint coatings to show compliance with requirements, e.g. all tested performances, substrate preparation, applied coating layers and required DFT of each.
   2. **Warranty Exclusions:** Submit written documentation from the Product Manufacturer that there is no exclusions that would make the Project warranty not valid as a result of its location and environmental location.

C. **Samples:** As required under the individual Specification Sections, except where appearance characteristics are required to match between products from different Manufacturers, submit samples of all products so that appearance characteristics can be reviewed by the Architect under a single submittal.

1.08 **QUALITY ASSURANCE:**

A. **High Performance Paint Coating Applicator:**
   1. **License:** Licensed by the High Performance Paint Manufacturer
for application of each Project specific paint coating system.

2. **High Performance Coating Experience**: Eight (8) years minimum, applying specific Project required paint systems successfully on projects of similar scope and paint installation complexity.

1.09 **WARRANTY**:

A. **Fluoropolymer Paint Coating Warranty**: Submit a written and executed "Manufacturing Defects Warranty" from the licensed Paint Coating Applicator for period of twenty (20) years; warranting performance for chalk and color change as specified herein.

**PART 2 - PRODUCTS**

2.01 **MATERIALS**:

A. **Fluoropolymer Paint Coating System**:

1. **System Type**: Contains 70% minimum of the Polyvinylidene Fluoride (PVDF) resin.

2. **Acceptable Products**: Compliant products based on Kynar 500 or Hylar 5000 resins, e.g. those from Azko Nobel, BASF, PPG or Valspar.

3. **Coatings**:
   a. **Weather Exposed Side**: Not less than 3 coat work, including substrate initial treatment, e.g. chrome phosphate, followed by the primer coat, PVDF color coat and final PVDF clear coat.
   b. **Non-Weather Exposed Side**: For sheet materials, provide with standard polyester coating.

4. **Color and Gloss**: Custom color and gloss to be selected by the Architect, except not less than semi-gloss, unless lower gloss level specified in Product Specification Section.

B. **Powder Paint Coating System**:

1. **Type**: AAMA 603.8, TGIC polyester powder coating.

2. **Available Products**: One of following.
   a. **Dupont Powder Coatings**.
   b. **Morton Powder Coatings**.
c. Tiger Drylac.


4. **Texture**: Smooth.

5. **Color**: Custom color to be selected by Architect.

C. **Anodizing**: Meets class specified in clear anodized color, unless otherwise indicated.

2.02 RELATED MATERIALS:

A. **Fluoropolymer Touchup Paint Coating**: Wherever fluoropolymer paint coatings are required, provide a field appliable fluoropolymer paint coating, color matched to each paint color and gloss required for the Project.

B. **Powder Touchup Paint Coating**: As recommended by the Powder Coating Paint Manufacturer for each Project specific product exposure, e.g. exterior or interior, and compatible with each powder coating type for which a touchup coating is required.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. **Product Installation – General**: Refer to individual Specification Sections covering products that require shop-applied finishes.

END OF SECTION
SECTION 05120 – STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following:
   1. Structural Steel.
   2. Grout.

B. Related Sections include the following:
   1. Section 05300 - METAL DECKING.
   2. Section 05500 – METAL FABRICATIONS.
   3. Section 07250 - SPRAY-APPLIED FIREPROOFING.

1.02 DEFINITIONS:

A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.03 SUBMITTALS:

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
   5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
C. Welding certificates.

D. **Qualification Data:** For installer and fabricator.

E. **Mill Test Reports:** Signed by manufacturers certifying that the following products comply with requirements:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Direct-tension indicators.
4. Tension-control, high-strength bolt-nut-washer assemblies.
5. Shear stud connectors.

1.04 **QUALITY ASSURANCE:**

A. **Installer Qualifications:** A qualified installer specializing in performing the work of this section with minimum five years documented experience.

B. **Fabricator Qualifications:** A qualified fabricator specializing in performing the work of this section with minimum five years documented experience.

C. **Welding:** Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
4. AISC's "Specification for the Design of Steel Hollow Structural Sections."

6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.05 DELIVERY, STORAGE AND HANDLING:

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.

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

1.06 COORDINATION:

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS:

A. **W-Shapes**: ASTM A 992/A 992M.

B. **Channels, Angles**: ASTM A 36/A 36M.

C. **Plate and Bar**: ASTM A 36/A 36M unless indicated otherwise on structural drawings.

D. **Cold-Formed Hollow Structural Sections**: ASTM A 500, Grade B, structural tubing.

E. **Steel Pipe**: ASTM A 53/A 53M, Type E or S, Grade B.

1. **Weight Class**: As indicated on the structural drawings.

2. **Finish**: Galvanized.
F.  **Welding Electrodes:** Comply with AWS requirements.

2.02 **BOLTS, CONNECTORS AND ANCHORS:**

A. **High-Strength Bolts, Nuts, and Washers:** ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
  
  1. **Finish:** Mechanically deposited zinc coating for exterior use, ASTM B 695, Class 50.
  
  2. **Direct-Tension Indicators:** ASTM F 959, Type 325 compressible-washer type.
    
    a. **Finish:** Mechanically deposited zinc coating for exterior use, ASTM B 695, Class 50.

B. **Shear Connectors:** ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

C. **Unheaded Anchor Rods:** ASTM F 1554, Grade 55, weldable.
  
  1. **Configuration:** Hooked.
  
  2. **Nuts:** ASTM A 563 hex carbon steel.
  
  3. **Plate Washers:** ASTM A 36/A 36M carbon steel.
  
  4. **Washers:** ASTM F 436 hardened carbon steel.
  
  5. **Finish:** Mechanically deposited zinc coating, ASTM B 695, Class 50.

D. **Headed Anchor Rods:** ASTM F 1554, Grade 55, weldable, straight.
  
  1. **Nuts:** ASTM A 563 hex carbon steel.
  
  2. **Plate Washers:** ASTM A 36/A 36M carbon steel.
  
  3. **Washers:** ASTM F 436 hardened carbon steel.
  
  4. **Finish:** Mechanically deposited zinc coating, ASTM B 695, Class 50.

E. **Threaded Rods:** ASTM A193 Grade B7.
  
  1. **Nuts:** ASTM A 563 hex carbon steel.
  
  2. **Washers:** ASTM A 36/A 36M carbon steel.
3. **Finish:** Mechanically deposited zinc coating, ASTM B 695, Class 50.

### 2.03 PRIMER:

A. **Primer:** Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

B. **Galvanizing Repair Paint:** SSPC-Paint 20 or ASTM A 780.

### 2.04 GROUT:

A. **Nonmetallic, Shrinkage-Resistant Grout:** ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

### 2.05 FABRICATION:

A. **Structural Steel:** Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings."

1. Camber structural-steel members where indicated.

2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.

3. Mark and match-mark materials for field assembly.

4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. **Thermal Cutting:** Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. **Bolt Holes:** Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. **Finishing:** Accurately finish ends of columns and other members transmitting bearing loads.

E. **Cleaning:** Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."
F. **Shear Connectors:** Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

G. **Welded Door Frames:** Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches o.c., unless otherwise indicated.

H. **Holes:** Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces.

2. **Base-Plate 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.

**2.06 SHOP CONNECTIONS:**

A. **High-Strength Bolts:** Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. **Joint Type:** Snug tightened.

B. **Weld Connections:** Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

**2.07 SHOP PRIMING:**

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials.
5. Galvanized surfaces.

B. **Surface Preparation**: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   
   1. SSPC-SP 2, "Hand Tool Cleaning."

C. **Priming**: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

D. **Painting**: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.08 **GALVANIZING**:

A. **Hot-Dip Galvanized Finish**: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
   
   1. Fill vent holes and grind smooth after galvanizing.

2.09 **SOURCE QUALITY CONTROL**:

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
   
   1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. **Bolted Connections**: Shop-bolted connections will be tested and inspected according to RCSC’s "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. **Welded Connections**: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency’s option:
   1. **Liquid Penetrant Inspection**: ASTM E 165.
   2. **Magnetic Particle Inspection**: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   3. **Ultrasonic Inspection**: ASTM E 164.
   4. **Radiographic Inspection**: ASTM E 94.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
   1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

**PART 3 -EXECUTION**

3.01 **EXAMINATION**:

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

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

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

B. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION:

A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings."


1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.

2. Snug-tighten anchor rods 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 before packing with grout.

3. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.04 FIELD CONNECTIONS:

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.


2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
3.05  **REPAIRS AND PROTECTION:**

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. **Touchup Painting:** After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
   2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

3.06  **FIELD QUALITY CONTROL:**

A. **Testing and Inspection Agency:** Owner will engage a qualified independent testing and inspecting agency to perform the tests and inspections listed herein and to prepare reports:
   1. High Strength Bolting.
   2. Field Welding.

B. **Bolted Connections:** Field-bolted connections will be tested and inspected according to RCSC's "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."

C. **Welded Connections:** Field welds will be visually inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
   1. **Liquid Penetrant Inspection:** ASTM E 165.
   2. **Magnetic Particle Inspection:** ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   3. **Ultrasonic Inspection:** ASTM E 164.
   4. **Radiographic Inspection:** ASTM E 94.

**END OF SECTION**
SECTION 05310 – STEEL DECK

PART 1 – GENERAL

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

1.02 SUMMARY:
   A. This Section includes the following:
      1. Roof deck.
   B. Related Sections include the following:
      1. Division - 5 Section: "Structural Steel" for shop- and field-welded shear connectors.
      2. Division - 5 Section: "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.03 SUBMITTALS:
   A. Product Data: For each type of deck, accessory, and product indicated.
   B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
   C. Product Certificates: For each type of steel deck, signed by product manufacturer.
   D. Welding certificates.
   E. Field quality-control test and inspection reports.
   F. Research/Evaluation Reports: For steel deck.

1.04 QUALITY ASSURANCE:
   A. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
B. **Welding**: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

C. **Fire-Test-Response Characteristics**: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. **Fire-Resistance Ratings**: Indicated by design designations of applicable testing and inspecting agency.

2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

D. **AISI Specifications**: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

**1.05 DELIVERY, STORAGE AND HANDLING:**

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS:**

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

1. **Steel Deck:**
   a. Verco Manufacturing Co.

**2.02 ROOF DECK:**

A. **Steel Roof Deck**: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
1. **Galvanized Steel Sheet**: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.

2. **Deck Profile**: As indicated.

3. **Profile Depth**: As indicated.

4. **Design Uncoated-Steel Thickness**: As indicated.

5. **Side Laps**: As indicated.

**2.03 ACCESSORIES:**

A. **General**: Provide manufacturer’s standard accessory materials for deck that comply with requirements indicated.

B. **Mechanical Fasteners**: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. **Side-Lap Fasteners**: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

D. **Vent-Tabs**: Provide factory punched vents projecting upwards in interior low flutes approximately 6 inches on center for ventilation of structural concrete at areas exposed to weather, areas where waterproofing is used or where architectural flooring requires it.

E. **Flexible Closure Strips**: Vulcanized, closed-cell, synthetic rubber.

F. **Miscellaneous Sheet Metal Deck Accessories**: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

G. **Pour Stops and Girder Fillers**: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile indicated on the drawings.

H. **Column Closures, End Closures, Z-Closures, and Cover Plates**: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

I. **Piercing Hanger Tabs**: Piercing steel sheet hanger attachment devices for use with floor deck.

J. **Weld Washers**: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
K. **Galvanizing Repair Paint:** ASTM A 780 or SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.02 **INSTALLATION, GENERAL:**

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
3.03 ROOF-DECK INSTALLATION:

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows.

1. **Weld Diameter**: As indicated.
2. **Weld Spacing**: Weld edge and interior ribs of deck units as indicated.
3. **Weld Washers**: Install weld washers at each weld location.

B. **Side-Lap and Perimeter Edge Fastening**: Fasten side laps and perimeter edges of panels between supports as indicated.

C. **End Bearing**: Install deck ends over supporting frame with a minimum end bearing of 2 inches (51 mm), with end joints as follows:

1. **End joints**: Butted.

D. **Miscellaneous Roof-Deck Accessories**: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. **Weld cover plates at changes in direction of roof-deck panels**, unless otherwise indicated.

E. **Flexible Closure Strips**: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.04 FIELD QUALITY CONTROL:

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

B. Field welds will be subject to inspection.

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

D. Remove and replace work that does not comply with specified requirements.
E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS AND PROTECTION:

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 05400 – COLD-FORMED METAL FRAMING

PART 1 – GENERAL

1.01 SUMMARY:

A. **Section includes:** Light gage metal framing.

B. **Related Sections:**

   1. Section 09250 - GYPSUM BOARD ASSEMBLIES: For interior non-load-bearing metal stud framing and ceiling-suspension assemblies.

1.02 REFERENCES:


B. **ASTM A 653** - Specification for General Requirements for Steel Sheet Zinc-Coated (Galvanized) by the Hot-Dip Process.


E. **SSMA** - Steel Stud Manufacturers Association.

F. **American Iron and Steel Institute, AISI:** Specification for Design of Cold-Formed Steel Structural Members.

1.03 SUBMITTALS:

A. Submit under provisions of Section 01330 - SUBMITTAL PROCEDURES.

B. **Product data:** Product data for each type of cold-formed metal framing, accessory, and product specified: Mill certificates signed by manufacturers of cold-formed metal framing certifying that their products comply with the requirements, including uncoated steel thickness, yield strength, tensile strength, total elongation, and galvanized-coating thickness. In lieu of mill certificates, submit test reports from a qualified independent testing agency evidencing compliance with requirements.
C. **Shop drawings:** Shop drawings showing layout, spacing, sizes, thickness, and types of cold-formed metal framing, fabrication, fastening, and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, connection details, and attachments to other units of Work. For cold-formed metal framing indicated to comply with certain design loadings, include structural analysis data sealed and signed by the qualified professional engineer who was responsible for its preparation.

D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. **Product Test Reports:** From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Expansion anchors.
2. Power-actuated anchors.
4. Mechanical fasteners.

F. **Research/Evaluation Reports:** For cold-formed metal framing.

1.04 **QUALITY ASSURANCE:**

A. **Installer Qualifications:** Engage an experienced Installer who has complete cold-formed metal framing similar in material, design and extent to that indicated for this Project and with a record of successful in-service performance.

B. **Welding Standards:** Comply with applicable provisions of AWS D1.1 "Structural welding Code --Steel" and AWS D1.3 "Structural Welding Code -Sheet Steel."

C. **Fire-Test-Response Characteristics:** Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. **Fire-Resistance Ratings:** As indicated by design designations listed in UL "Fire Resistance Directory", or by Warnock Hersey or another testing and inspecting agency acceptable to authorities having jurisdiction.
1.05 **DELIVERY, STORAGE AND HANDLING:**

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

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CEMCO Angeles Metal Systems.
3. Dietrich Industries, Inc.

2.02 **MATERIALS:**

A. **Galvanized-Steel Sheet:** ASTM A 653 (ASTM A 653M), zinc coated according to ASTM A 653 (ASTM A 653M), and as follows:

1. **Coating Designation:** G90.
2. **Grade:** As indicated on Structural Drawings.

B. **Steel Track:** Manufacturer's standard U-shaped steel track, unpunched, of web depths indicated, with straight flanges, complying with ASTM A653, the SSMA and the following:

1. **Design Uncoated -Steel Thickness:** As indicated on Drawings.
2. **Flange Width:** As indicated on Drawings.

C. **Steel Studs:** Manufacturer's standard C-shaped steel studs, of web depths, flange widths and Section properties as indicated on Drawings, punched, with stiffened flanges, complying with ASTM A653, and the SSMA.
2.03 **FRAMING ACCESSORIES:**

A. Fabricate steel-framing accessories of the same material and finish used for framing members, with a minimum yield strength of 33,00 psi (230Mpa).

B. Where indicated on the Drawings or otherwise required to complete each installation, 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.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers, knee braces and girts.
9. Joist hangers and end closures.

2.04 **ANCHORS, CLIPS AND FASTENERS:**

A. Refer to Drawings for fastening requirements. Provide fasteners indicated unless directed otherwise.

B. **Steel Shapes and Clips:** ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

C. **Expansion Anchors:** Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
D. **Power-Actuated Anchors**: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. **Mechanical Fasteners**: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

F. **Head Type**: Low-profile head beneath sheathing, manufacturer's standard elsewhere

2.05 **MISCELLANEOUS MATERIALS**:

A. **Galvanizing Repair Paint**: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

2.06 **FABRICATION**:

A. Fabricate cold-formed metal 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.

B. Fabricate framing assemblies using jigs or templates.

C. Cut framing members by sawing or shearing; do not torch cut.

D. Fasten cold-formed metal framing members by screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

E. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

F. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

G. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

H. **Fabrication Tolerances**: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960).
I. **Spacing:** Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

J. **Squareness:** Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

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

3.02 **INSTALLATION, GENERAL:**

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

C. Cut framing members by sawing or shearing; do not torch cut.

D. Fasten cold-formed metal framing members by screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

E. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

F. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

G. 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.

H. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
I. Install insulation, specified in Section 07210 "Building 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.

J. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

K. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet.

L. 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.

3.03 EXTERIOR LOAD-BEARING WALL INSTALLATION:

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated.

C. Stud Spacing: As indicated on the Drawings.

D. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements. Extend stud system through ceilings and elsewhere as indicated to the structural support or substrate above ceiling.

E. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

F. Connect vertical deflection clips to infill studs and anchor to building structure.

G. Connect drift clips to cold formed metal framing and anchor to building structure.

H. Provide permanent bracing in the form of steel strapping 1-1/2 inch x 20 gauge minimum with strapping running horizontally on both sides of studs, attached to each flange, and spaced at 4'-0" vertically to align with sheathing panel edges. Solid blocking channels that are aligned with strapping shall be provided between studs at each end of wall and adjacent to openings.
I. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.04 FIELD QUALITY CONTROL:

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

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

3.05 REPAIRS AND PROTECTION:

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer’s written instructions.

B. Touchup Painting: Wire brush, clean, and paint scarred areas, welds, and rust spots on fabricated and installed prime-painted, cold-formed metal framing. Touchup painted surfaces with same type of shop paint used on adjacent surfaces.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Custom metal fabrications.
      2. Premanufactured fabrications.
   B. Related Sections:
      1. Division 1 – Sections.
      2. Division 3 – Cast-In-Place Concrete.
      3. Division 5 – Structural Steel.
      4. Division 5 – Metal Fabrications - Steel.

1.03 DEFINITIONS:
   A. Custom Metal Fabrications: Metal fabrications that are assembled from various types of premanufactured metal components to meet specific custom Project purposes.
   B. Premanufactured Metal Fabrications: Metal fabrications that are factory fabricated for specific architectural purposes. These products may require modification to meet Project requirements but their primary manufactured purpose is not altered.

1.04 SUBMITTALS:
   A. General:
      1. Submit in accordance with Section 01300 - SUBMITTALS.
      2. Refer to other Metal Fabrication Specification Sections.
   B. Quality Assurance Submittals: Refer to “Quality Assurance” paragraphs herein.
1.05 QUALITY ASSURANCE:

A. **Coordination:** Furnish data and materials, such as reinforcement data, anchorage devices, setting drawings, diagrams, and templates, to appropriate Trades requiring preparation of their work to receive metal fabrication products and to ensure proper coordination of the work.

1.06 DELIVERY, STORAGE & HANDLING:

A. **General:** Refer to Division 1 requirements.

B. **Defects:**

1. **General:** Specified requirements are for quality of work in place and does not take into account method of delivery, storage, and handling, until product is installed; which is each Manufacturer’s responsibility to ensure products are installed in “as-manufactured” quality into the Project and which meets the design intent.

2. **Corrosion:** In addition to any other defects, corrosion is considered a defect.

3. **Method of Protection:** Contractor and Manufacturer are to select additional methods of protection; if required, to fully protect the work during delivery, storage, and handling. Whether paint, galvanizing, or other methods are selected, final method shall not affect any subsequent applied finishes scheduled for each product. Where selected method is not compatible with subsequent finishes or affects design intent, such methods shall be brought to the attention of the University prior to purchase and fabrication of any such product for approval; unless such protection is fully removed prior to the application of final finishes and prior to start of any corrosion.

4. **Corrosion Removal:** Regardless of selected protection, corrosion to be fully removed from all surfaces prior to installation of subsequent finishes and prior to re-start of any corrosion. Where corrosion has deteriorated the metal where it is no longer repairable, such work shall be replaced with new Contract complying work; unless a structurally sound repair method is acceptable to University and is not visible in final exposed in-place work.

PART 2 - PRODUCTS

2.01 MATERIALS – METALS:

A. **Manufacturer Selections:** Manufacturer may select primary base metal materials as specified or other standard materials of higher quality and Project suitability in order to achieve proper structural, functional, and aesthetic performances of each product to meet Project conditions and
University’s final design intent; when acceptable to University. Where materials vary from those specified, submit justifications for each.

B. **Rigidity of Nonstructural Components**: Unless otherwise indicated or acceptable to University, comply with following.
   1. **Sheet**: 1/16” minimum thickness.
   2. **Other**: 1/8” minimum thickness

2.02 **MATERIALS – FINISHES**:

   A. **Hot Dipped Galvanizing**: ASTM B 6, Zinc of quality as specified conforming to specified ASTM standards under “Fabrication” paragraphs herein.

   B. **Paint Coating**: Field applied coatings by Division 9 - Paints & Coatings Installer.

   C. **Other**: As specified in individual metal fabrication sections for each metal type.

2.03 **TYPICAL RELATED MATERIALS**:

   A. **Anchorage Devices**: Selected and engineered by Manufacturer or Fabricator of fastened component for required Project structural performances and as follows.
      1. **General**: Complying with Division 5 – Fasteners & Anchors Section.
      2. **Anchorage of Steel Fabrications**: Ferrous devices; except hot dipped galvanized where fastening is into exterior wall, slab on grade, or where fabrication is located in wet or humid area, e.g. restrooms.
      3. **Anchorage of Galvanized Fabrications**: Hot dipped galvanized devices.
      4. **Anchorage of Aluminum Fabrications**: AISI alloy 300 series stainless steel devices.

   B. **Welding Electrodes**: AWS complying types and alloy as recommended by Fabricator of metal to be welded, and as required for color match, strength, and compatibility with required fabricated metals.

   C. **Shop Primer for Ferrous Metal**: Manufacturer's or Fabricator's standard, fast-curing, lead-free, "universal" primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure; complying with performance requirements of FS TT-P-645.
D. **Grout**: ASTM C 1107, non-shrink, non-metallic type, pre-mixed, factory packaged, non-staining, non-corrosive, non-gaseous grout; formulated for exterior and interior Project applications.

E. **Bituminous Paint**: SSPC-Paint 12 and ASTM D 1187, asphalt mastic coating.

2.04 **FABRICATION – GENERAL:**

A. **Design Intent**: Engineer fabrications with least amount of joints and exposed fasteners possible; except as required for proper structural and weather performances and Project assembly restrictions.

B. **Shop Assembly**: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation in the field.

C. **Components**: Material types, configurations, dimensions, and thickness as indicated; where not indicated, provide metals not less than 1/4" thickness, or as otherwise acceptable to University.

D. **Accurate Assemblies**: Form each work true to line and level with accurate angles, radius and surfaces.

E. **Forming**: Form each component to accurate design intent required; without distortion and without potential resulting defects in each material and forming process, e.g. grain separation.

F. **Blemishes**: Where exposed to view, use only materials which are smooth and free of surface blemishes, such as pitting, seam marks, roller marks, and rolled trade names. Blemishes on concealed work are acceptable, except where such blemishes are defects that would affect its ability to meet the structural performances required of the Work.

G. **Connections**:

1. **Non-Welded**: Internal mechanical connections.

2. **Welding or Brazing Methods**:
   a. **Method**: Utilize method that develops required engineered strength of joints.
   b. **Fusing**: Thoroughly fuse without undercutting or overlap.
   c. **Grinding**: Remove spatter and grind exposed joints and fusing materials to blend with adjacent surfaces and contours.
   d. **Discoloration**: Are not acceptable when visible in finished work.
3. **Joints:** Hairline; flush and smooth transitions between adjacent connected surfaces.

4. **Fasteners:** Engineer to conceal fasteners on exposed surfaces. Where exposed, countersink flush. Exposed portion of fasteners to match fastened surface.

**H. Expansion Joints:** Provide for proper expansion of all work.

**I. Weathering:** Fabricate work which is exposed to weather in a manner to exclude water and condensation where it would otherwise accumulate by means of concealed channels and weeps.

**J. Provisions for Work by Other Trades:** Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive work of other Trades.

2.05 **FABRICATION – FINISHES:**

**A. General:** Refer to individual product sections for finishes required.

**PART 3 - EXECUTION**

3.01 **PREPARATION:**

**A. Field Measurements:** Take field measurements prior to preparation of Shop Drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

3.02 **INSTALLATION:**

**A. General:** Comply with Manufacturer's and Fabricator's Project specific requirements as successfully reviewed by University on Shop Drawings and other required submittals.

**B. Fastening to In-Place Construction:** Provide anchorage devices where necessary for securing metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Grout in anchors with nonshrink grout when required.

**C. Cutting, Fitting and Placement:** Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete masonry or similar construction. Fit exposed connections accurately together to form tight hairline joints.
D. **Field Welding:** Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used on correcting welding work. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

E. **Incompatible Surfaces:**

1. **Separation:** Separate following from primary engineered metal components.
   a. Dissimilar metals.
   b. Portland cement materials, e.g. concrete, concrete masonry units, portland cement.
   c. Treated wood products.

2. **Method:** One of following.
   a. Bituminous paint.
   b. Manufacturer recommended two part epoxy paint.

3.03 **DEFECTIVE WORK, CLEANING & PROTECTIONS:**

A. **Defective Work:**

1. **General:** Replace damaged and deteriorated units, if any. Minor restoration may be accomplished, including touchup work, when not extensive, when not visible in repaired work and when final work is acceptable to University.

2. **Galvanizing:** Touch up minor damaged hot dipped galvanizing and field welds with zinc rich primer.

B. **Cleaning:** Comply with Division 1 requirements.

C. **Protections:** Protect installed units for duration of Contract Period so work is without damage and deterioration until acceptance by University.

END OF SECTION
SECTION 05501 – METAL FABRICATIONS – STEEL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Custom steel fabrications.
      2. Premanufactured steel fabrications.
   B. Related Sections:
      1. Division 1 – Sections.
      2. Division 3 – Cast-In-Place Concrete.
      3. Division 5 – Shop-Applied Coatings for Metal.
      4. Division 5 – Metal Fabrications - General.

1.03 DEFINITIONS:
   A. General: Refer to Division 5 – Metal Fabrications – General.

1.04 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data:
      1. Custom Fabrications: Submit data indicating materials comply with specifications.
      2. Premanufactured Fabrications and Related Materials: Submit each Product Manufacturer's standard product literature, specifications, engineered performances, details, and installation instructions.
   C. Shop Drawings: Submit Shop Drawings for fabrication and erection of miscellaneous metal fabrications. Include plans, elevations and details of sections and connections. Show anchorage and accessory items.
D. **Samples:** Submit following.
   1. **Handrails and Railings:** Submit a partial mockup of full height x 24” wide to show workmanship, e.g. welding, components, galvanizing and plugs, and painted finish.
   2. **Gratings:** Submit 8-1/2” x 11” samples of finished aluminum gratings.

E. **Quality Assurance Submittals:** Refer to “Quality Assurance” paragraphs herein.

1.05 **QUALITY ASSURANCE:**
   A. **Engineering:** Refer to Division 1 – Metal Fabrications – General.

1.05 **DELIVERY, STORAGE & HANDLING:**
   A. **General:** Refer to Division 1 requirements.
   B. **Defects and Corrosion:** Refer to Division 5 - Metal Fabrications - General Section.

**PART 2 - PRODUCTS**

2.01 **MATERIALS - GENERAL:**
   A. **General:** Refer to Division 5 – Metal Fabrications – General.
   B. **Steel Components:**
      1. **Plates, Shapes and Bars:** ASTM A 36, unless otherwise indicated.
      2. **Pipe:** ASTM A 53, Type F or S, Grade A, Schedule 40 or Schedule 80, hot dipped galvanized.
      3. **Tubing:** ASTM A 500 or ASTM A 513.
   C. **Castings:**
      1. **Gray Iron:** ASTM A 48, Class 30.
      2. **Malleable Iron:** ASTM A 47.

2.02 **CUSTOM METAL FABRICATION PRODUCTS:**
   A. **General:** Refer to “Fabrication” paragraphs herein.
2.03 PREMANUFACTURED METAL FABRICATION PRODUCTS:

A. Bollards: Manufacturer complying with Division 1 – Common Product Requirements – General Section and capable of providing bollards in accordance with the design intent of the Contract Documents.

2.04 RELATED MATERIALS:

A. Anchorage Devices: Refer to Division 5 – Metal Fabrications – General.

B. Grout: Refer to Division 5 – Metal Fabrications – General.

C. Paint Coatings - Shop Applied Systems:

1. Galvanizing: Refer to "Fabrication" paragraphs herein.

2. Powder Coating: Refer to "Fabrication" paragraphs herein.

3. Primer: Manufacturer's or Fabricator's standard, fast-curing, lead-free, "universal" primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure; complying with performance requirements of FS TT-P-645.

D. Paint Coating Systems - Field Applied:

1. Galvanizing Repair Paint: High zinc dust content paint complying with following.
   a. Coating Type: Organic zinc primer.
   b. Standards: Complies with two or more of following.
      1) DOD-P-21035A.
      2) MIL-P21035 (Ships).
      3) SSPC-Paint-20.
      4) FS TT-P-46, Type I.
   c. Primary Characteristics:
      1) Manufacturer Experience: 10 years minimum producing zinc rich primers.
      2) Zinc Content in Dry Film: 90% minimum.
      3) Coating Thickness: 3 mil dft minimum per coating.
      4) Electrical Conductivity: 70 million ohms / 3 mil dft.
5) **Resin Type:** Urethane or epoxy.

2. **Touchup Paint:** Following provided by or approved in writing by each Product Manufacturer.
   
a. **For Defective Shop Primers:** Same primer as used in shop or other field appliable compatible primer.
   
b. **For Defective Powder Coatings:** Compatible urethane or other industrial quality paint, color matched to each painted product and approved for use by Product Manufacturer.

### 2.05 FABRICATION – GENERAL:

A. **General:** Refer to Fabrication Paragraphs of Division 5 – Metal Fabrications – General Section.

### 2.06 FABRICATION – CUSTOM METAL FABRICATIONS:

A. **Miscellaneous Metal Fabrications:**

   1. **General:** Provide assemblies which are not a part of structural steel framework, as required to complete work. Furnish bent, or otherwise custom fabricated, bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required. Fabricate items to sizes, shapes and dimensions required. Where not otherwise indicated, fabricate from steel shapes, plates and bars. Cut, drill and tap units to receive hardware and similar items.

   2. **Anchors:** Where not otherwise indicated, equip units with means of anchoring. Use integrally welded anchors where required for casting into concrete or building into masonry. Furnish mechanical anchors with inserts if units must be installed after concrete is placed. Except as otherwise indicated, space anchors 24” o.c. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

### 2.07 FABRICATION – PREMANUFACTURED METAL FABRICATIONS:

A. **General:** Fabricate units in accordance with each Manufacturer's standard methods as necessary to meet Project requirements as specified hereunder and as fully indicated in submittals successfully reviewed by the University.

B. **Bollards:**

   1. **Type:** Removable.

   2. **Materials:** All steel components to be hot dipped galvanized after fabrication.
3. **Primary Characteristics:**

   a. **Materials:** Following, unless otherwise acceptable to the University.
      
      1) **General:** For pipe and related components comply with "Materials – General" paragraphs.
      
      2) **Related Components:** 1/4” cross sectional thickness minimum.

   b. **Base Sleeve:** Manufacturer’s standard sleeve for embedment in concrete footing. Sleeve to have flush and internally hinged cover or separate flush cover that can be fastened in place to the adjacent sleeve construction, e.g. hex head screw, when bollard is removed.

   c. **Padlock Provision:** Manufacturer’s standard integral padlocking provision, e.g. hole in open hinge cover engages heavy welded eye on bollard or other integral device acceptable to the University.

   d. **Bollard:** 4.5” O.D. steel pipe minimum with welded metal top closure plate.

   e. **Finish:** Powder coat complying with Division 5 – Shop Applied Finishes for Metal Section.

2.08 **FABRICATION – FINISHES:**

   A. **General:** Finishes hereunder when specified for metal fabrications in other Sections to comply with following in addition to any other requirements indicated.

   B. **Galvanizing:**

      1. **For:** All assemblies with some part of the assembly exposed to following conditions; regardless of subsequent scheduled finishes.

      a. Exposed to exterior air.

      b. Be in contact with or part of an exterior envelope construction, e.g. exterior wall assembly, or exterior concrete or masonry wall; including when on the interior side of the construction.

      c. In contact with any slab on grade.

      2. **General:** Comply with AGA (American Galvanizers Association) publications and standards.

      3. **Requirement:** Hot dip galvanize base fabricated ferrous metal assemblies after fabrication in conformance with ASTM A 153 and
ASTM A 123 as applicable to the type of fabrication. Plug all galvanizing vent holes on tubular work. Concealed from view holes for weeping are to be kept open.

C. **Shop Painting - Primer Paint:**

1. **For:** Steel fabrications not requiring galvanizing.

2. **Surface Preparation:** As required to remove deleterious materials, but not less than SSPC-SP3 "Power Tool Cleaning".

3. **Application:** Apply shop primer to surfaces of metal fabrications except those which are galvanized, unless otherwise indicated, and in compliance with requirements of SSPC-PA1 "Paint Application Specification No.1" for shop painting. Strip paint at all edges, corners, crevices, bolts, welds, and sharp edges.

D. **Shop Painting - Powder Paint Coating:** Comply with Division 5 – Shop-Applied Coatings for Metal Section.

E. **Field Painting:** Provide for all other work complying with Division 9 - Paint and Coating Section, that is not covered by the specifications herein and except for prefinished, pre-manufactured metal fabrications.

**PART 3 - EXECUTION**

3.01 **PREPARATION:**

A. **Field Measurements:** Take field measurements prior to preparation of Shop Drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

3.02 **INSTALLATION:**

A. **General:** Refer to Division 5 – Metal Fabrications – General Section.

3.03 **TOUCHUP, REPAIR, AND CLEANING:**

A. **General:** Refer to Division 5 – Metal Fabrications – General Section.

B. **Touch-Up:**

1. **Ferrous Surfaces:** Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray touchup of shop primer in published one coating rate but not less than 2.0 mils.
2. **Galvanized Surfaces:** Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

3. **Paint Coated Surfaces:** Minor abraded areas may be touched up when only a few places and when acceptable to University. Apply each color matched paint by small touch up artist brush. Refer to Division 1 Sections for restrictions on work requiring touch up with exposed paint coatings.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 5 – Metal Fabrications - Common Work Results.
      3. Division 11 – Laboratory Equipment.
      4. Division 12 – Specialty Casework.

1.03 DEFINITIONS:
   A. General: Refer to Division 5 – Metal Fabrications – General.
   C. NiDI: Nickel Development Institute.
   D. SSINA: Specialty Steel Industry of North America.

1.04 SUBMITTALS:
   A. Product Data: Submit data for all materials and components required for each type of metal fabrication.
   B. Shop Drawings: Submit Shop Drawings for fabrication and erection of metal fabrications. Include plans, elevations and details of sections and connections. Show anchorage and accessory items. Show relationship to adjacent work.
   C. Samples: Refer to each Specification Section requiring stainless steel components.
   D. Quality Assurance Submittals: Refer to “Quality Assurance” paragraphs herein.
1.05 **QUALITY ASSURANCE:**

A. **Standards:** All work to comply with applicable standards and publications of the following.
   1. NiDI.
   2. SSINA.

B. **Engineering:** Refer to Division 1 – Metal Fabrications – General.

**PART 2 - PRODUCTS**

2.01 **STAINLESS STEEL MATERIALS - GENERAL:**

A. **Metal Alloy:** AISI Type 304, unless higher alloy indicated.

B. **Form:** As indicated, e.g. plate, shape, bar, tube, pipe and sheet complying with SSINA Designer Handbook "Specifications for Stainless Steel" publication.

2.02 **RELATED MATERIALS:**

A. **Welding Materials:** Comply with AISI Handbook Series No.9 002 "Welding of Stainless Steel and Other Joining Methods" for selection of materials applicable to each stainless alloy required for Project.

B. **Anchorage Devices:** Type 300 series alloy stainless steel products complying with Division 1 - Common Product Requirements - Fasteners & Anchors Section.

C. **Metal Reinforcements:** As required for each work. Components to be stainless steel.

D. **Other:** Refer to Division 5 – Metal Fabrications – General.

2.03 **FABRICATION – GENERAL:**

A. **General:** Comply with following.
   1. **Design Intent:** Refer to Fabrication Paragraphs of Division 5 – Metal Fabrications – Common Work Results Section.

B. **Passivation:** All products to be fully passivated to prevent ferrous contamination.

C. **Finish:** No.4, brushed finish, unless otherwise indicated or scheduled.
2.04 FABRICATION – PRODUCT SPECIFIC:
A. General: Refer to specific Specification Sections with stainless steel products.

PART 3 - EXECUTION

3.01 INSTALLATION:
A. General: Refer to Division 5 – Metal Fabrications – General Section.

3.02 DEFECTS, CLEANING & PROTECTIONS:
A. General: Refer to Division 5 – Metal Fabrications – General Section.

END OF SECTION
SECTION 06070 – WOOD TREATMENT

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS:
A. As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:

B. Related Sections:
   1. Division 1 – Sections.
   2. Division 6 – Rough Carpentry.
   3. Other Specification Sections using rough carpentry products.

C. Products Furnished but not Installed:
   1. Topical treatment materials.

1.03 DEFINITIONS:

B. Treatment Manufacturer: Entities who market and manufacture specific chemical formulations and methods of treatment under specific proprietary names.

C. Treatment Plant: Entities that possess the physical facilities to treat wood products in accordance with the Treatment Manufacturer's requirements and is a certified Applicator of the Treatment Manufacturer.

1.04 SYSTEM DESCRIPTION:
A. Treatment Intent – Wood Products To Be Treated: All structural and non-structural wood products specified in Division 6 – Rough Carpentry and indicated on Structural Drawings are required to be treated in accordance with this Specification Section, unless otherwise specified or unless otherwise approved by the Architect prior to Bid.
B. **Treatment Intent – Code and Industry Compliance:** Treatments to comply with all of the following.

1. **AWPA Standards:** Complies with AWPA U1 Standard, “Use Category System: User Specification for Treated Wood” and consisting of U1 and T1 standards.

2. **Applicable Codes:** Complies with jurisdictional Code requirements, e.g. IBC 2006 and current State of Hawaii “Building Code (Administrative Rules, Title 3, Chapter 3-180)” requirements for the treatment of wood products.

3. **Specified Requirements:** Complies with the requirements specified herein.

C. **Treatment Intent – Performances:**

1. **General:**
   a. **Insecticide Performance:** All treatment chemicals to comply with insecticide performances specified.
   b. **Fire Retardant Performance:** As scheduled herein and as otherwise indicated.
   c. **Fungicide Performance:** As required by specified Code and Industry compliances for exterior and interior damp exposed wood products.

2. **Penetration and Retention:** Where difference in penetration and retention differs between specified requirements and related Code requirements for any specific wood use under the AWPA U1 “Use” descriptions, provide the requirement achieving the higher penetration and retention rate as applicable to the specific wood specie required to be treated for this Project.

3. **Insecticide – Termite Treatment Efficacy:** All types of pressure treatment chemicals for any AWPA Use wood product and wood specie is to have a tested efficacy no less than that achieved by the AWPA using standard P5 for 0.28 pcf, SBX treated Douglas Fir wood and when exposed to subterranean termites, including the specie coptotermes formosanus, based upon qualified Third Party Testing acceptable to the University and based on an AWPA E1 or other University AWPA testing, e.g. E10, E12, or E21.

4. **Fire Retardant Performance:** Meets ASTM E 84 (or UL 723, or NFPA 255), Class I or A requirements.

5. **Fungicide Performance:** AWPA E10 or ASTM D 1413 tested with no fungal decay but not greater than 2% maximum decay for the treated specimens and when compared with the untreated control specimens.
showing a 20% to 60% fungal decay over a 12 week or other University acceptable testing period.

1.04 **SUBMITTALS:**

A. **General:** Submit in accordance with Section 01300 - SUBMITTALS.

B. **Product Data:**

1. **General:** Submit pressure and topical treatment data for each treatment chemical, including formulations, MSDS sheets, treatment methods, and expected penetration and retention rates for each wood species required to be treated in the Project.

2. **Pressure Treatment – Penetration and Retention Rates:** Submit a list comparing the penetration and retention rate for each wood product required to be treated. The comparison list should contain the following column headings.

   a. AWPA “Use” designation.
   b. Treated specie.
   c. Specified penetration and retention rate.
   d. Authority penetration and retention rate.
   e. Actual penetration and retention rate to be provided.
   f. Indicate whether product is “structural” or “non-structural”.
   g. “Comments” column to explain any penetration and retention that is different than the specified requirements or any other explanation necessary where a deviation from the specified requirements may occur.

C. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraphs.

1.05 **QUALITY ASSURANCE:**

A. **Contractor Certification:** Submit written certification that all wood products required to be treated, have been treated in accordance with these Specifications and that no untreated products that are required to treated have been used in the Project.

B. **Pressure Treatment:**

1. **Treatment Certification:** Submit Treatment Plant's written certification that Project products have been treated in conformance with Treatment Manufacturer's and Contract requirements. Certificates to indicate following for each wood member (by form, specie, and size).

   a. Treatment standard and process.
b. Penetration and retention rates.
c. Quantity of materials treated.

2. **Identifications Indicating Treatment Quality:**
   a. **Labels:** Comply with label marks on wood products as required by Authorities.
   
   b. **Restriction:** For woods exposed to view and where marks would be visible in the final in-place, finished work, e.g. where the work is scheduled to be left unfinished or transparent finished (e.g. stained), or both, secure Architect’s approval for location of marks.

3. **Engineered Wood (EW) Product Manufacturer’s Certification:** Submit each EW Product Manufacturer’s written certification that the specified treatment chemicals and methods scheduled for each of their engineered products have been successfully used historically with their engineered products and are approved by them for use on the Project specific products. Where the specified requirements are not capable of being approved by any EW Product Manufacturer, provide an alternate treatment method complying with the Contract Intent that is acceptable to the University prior to Bid.

4. **Incised Material Restrictions:** If incising required for any work, verify the following prior to purchase and manufacture of any incised work.
   a. Incising may be acceptable to the University only where there is no other way to achieve proper treatment of any specific specie wood product.
   
   b. For structural members, where incising is not specifically indicated on the Structural Drawings, verify that the University’s Structural Engineer Consultant has compensated for the reduced strength of any scheduled incised structural members.
   
   c. Do not use any incised work where such work would be exposed to view in the final in-place work from any vantage point and any viewing distance.

C. **Topical Treatment:** Scheduled treatments are not to invalidate conditions of required Project Warrantees. Verify Warrantor’s acceptable methods and comply strictly with their requirements which should not be less than the methods specified herein.

D. **Products Scheduled for Transparent Finishes:** Do not begin wood treatment of products scheduled for transparent finishes, until samples of treated and finished wood has been successfully reviewed by the University.
E. Non-Specified AWPA UC1 Work:

1. UC4B and Higher UC# and UCFB Categories: If any Project wood products fall into these Use Categories, verify the treatment requirements for such work prior to Bid or provide treatment in compliance with AWPA U1 applicable to the product and specie.

2. Ground Contact Use Products: If any, cut to size prior to pressure treatment. Field cutting of such products is not allowed, unless subsequent treatment can attain 100% penetration of any untreated portion of field cut work.

PART 2 – PRODUCTS

2.01 MANUFACTURERS:

A. Basis of Design: Design is based upon products specified below which may be incorporated into the Project; subject to compliance with the requirements.

2.02 PRESSURE TREATMENT MATERIALS & METHODS:

A. AWPA U1: Provide UC1 though UC4A compliant work as applicable to each "Use" product type and specie, unless otherwise specified hereunder.

B. Insecticide Treatments:

1. WT-1, Borate Oxide (SBX):
   a. Retention: 0.28 pcf minimum.
   b. Penetration: Per AWPA standard as applicable to each Project wood specie.
   c. Acceptable Products: United States Borax & Chemical Corporation "Tim-Bor" (as specifically licensed by Manufacturer to Treatment Company for sale as Hi-Bor PTW) or preapproved equal product.

2. WT-2, Permethrin/IPBC: Not used.

C. Insecticide and Fire Retardant Treatments:

1. WT-3, EPA Formulation FR-1:
   a. Retention: Per AWPA standard minimum as applicable to each Project wood specie.
   b. Penetration: Per AWPA standard as applicable to each Project wood specie.
c. **Product:** Arch Wood Protection "Dricon" or preapproved equal product.

d. **Heat and Corrosion Degradation Characteristics:** Acceptable products are not to contain mono-ammonium phosphate or other materials causing heat or humidity, or both, structural strength degradation for forty (40) years minimum beyond the Manufacturer’s published strength properties for wood materials treated with their treatment chemicals.

### 2.03 TOPICAL TREATMENT MATERIALS:

A. **WT-4, Borate Oxide (SBX):** Honolulu Wood Treating Company “Clear-Bor FT" or preapproved equal product.

### 2.04 MOISTURE CONTENT:

A. **Moisture Content of Treated Products:**

1. **Before Treatment:** Adjust moisture content to ensure proper treatment quality of products in accordance with Treatment Manufacturer’s requirements.

2. **After Treatment:** Reduce moisture levels after treatment to 19% maximum for lumber and 18% maximum for plywood. For cavity encapsulated concealed treated wood materials, ensure at time just before each material is fully enclosed by subsequent finishes that moisture content of such treated materials do not exceed the 19% moisture content for lumber and 18% for plywood.

B. **Defective Material:** Inspect each piece of treated material for defects resulting from treatment process. Replace defective materials with treated materials without defects.

### PART 3 – EXECUTION

### 3.01 SCHEDULE:

A. **General:** Schedule hereunder applies to wood products specified in Division 6 – Rough Carpentry Section.

B. **Pressure Treatment – Insecticide:**

1. **WT-1, Borate Oxide (SBX):** All structural and non-structural wood products not covered by other WT-# treatments herein.

2. **WT-2, Permethrin/IPBC:** Not used.
C. Pressure Treatment – Insecticide and Fire Retardant:

1. WT-3, EPA Formulation FR-1:
   a. Backer boards required for mounting of telephone and electrical equipment.
   b. “Miscellaneous Lumber” for lumber part of roofing work and for lumber required for firestops.
   c. Any other wood products requiring fire retardant treatment by the Authorities.

D. Topical Treatment:

1. WT-4: For all untreated field cut surfaces of pressure treated wood components. Comply with AWPA M4 and Pressure Treatment Chemical Manufacturer’s requirements to ensure that maximum penetration occurs that is possible by a topical treatment method, regardless of the applied method. Fully dry field treated cut surfaces before subsequent work is performed.
SECTION 06100 – ROUGH CARPENTRY

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Non-structural lumber.
      2. Construction panels
      3. Related materials.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 1 – Common Product Requirements - Fasteners & Anchors.
      3. Division 6 – Wood Treatment.
      4. All other Sections with products requiring rough carpentry work.
   C. Installed but Not Furnished:
      1. Division 6 - Wood Treatment, topical wood treatment chemicals.
   D. Furnished but Not Installed:
      1. Samples of wood products to Division 9 – Paints & Coatings Installer
         as required by University for review of paint finished work.

1.03 DEFINITIONS:
   A. WWPA: Western Wood Products Association.
   B. WCLIB: West Coast Lumber Inspection Bureau.

1.04 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: Submit data on all materials to show compliance with
                  Contract requirements.
1.05 QUALITY ASSURANCE:

A. Grading and Treatment Marks:
   1. **Wood Grade Quality Stamps:** All lumber and construction panels to have applicable grade marks.
   2. **Wood Treatment Information:** Comply with Division 6 – Wood Treatment Section.

B. Moisture Content: At time of manufacture, limit to 19% maximum.

C. Wood Treatment:
   1. **General:** Unless otherwise indicated, treat all work herein in accordance with Division 6 – Wood Treatment Section.
   2. **Ground Contract Use Work:** If any, work to be cut to size before wood treatment of wood components. Field cutting not allowed for such work.
   3. **Topical Treatment:** Methods to comply with conditions of Treatment Warranty and AWPA M4.

D. Defects: In addition to any other defects, comply with following.
   1. Do not install crooked, bowed, twisted, and split lumber.
   2. Do not install lumber with loose knots and knot holes.
   3. Do not install exposed lumber with splits.

E. Nailing Restrictions:
   1. No waxed, oiled, and greased nails permitted.
   2. No "shiners" in exposed and semi-exposed work.

F. Miscellaneous Lumber: Coordinate requirements with other Trades to ensure proper support of each work including, but not limited to, following.
   1. As shown.
   2. Mounted equipment and fixtures, e.g., architectural woodwork, hardware, bath accessories, mechanical work, and electrical work.
   3. Roofing and flashing and sheet metal work.
PART 2 – PRODUCTS

2.01 LUMBER – GENERAL:

A. General Requirements: Unless otherwise specified, comply with following.

1. **Standard:** Applicable WWPA or WCLIB standards.

2. **Specie Group:** Douglas Fir – Larch.

3. **Grades:** Indicated grades are minimums.

4. **Form:** Solid lumber and veneer, e.g. for panels, as indicated.

5. **Size:** Nominal sizes are indicated. Dressed sizes to comply with DOC PS 20. Where any indicated size exceeds typical dressed size, provide size cut to net size indicated, unless otherwise acceptable to University.

6. **Dressing:** S4S for all work; unless otherwise indicated or unless otherwise acceptable to University.

2.02 LUMBER – NON-STRUCTURAL PRODUCTS:

A. Miscellaneous Lumber:

1. **For:** Concealed, non-structural framing, e.g., blocking, nailers, furring, grounds, fire stops, supports for other applied work, etc.

2. **Specie Group:** Douglas Fir - Larch.

3. **Boards:** WWPA or WCLIB, Standard Grade.

4. **Dimension Lumber:** WWPA or WCLIB, Stud or No.2 Grade.

5. **Size:** Net size when required; but not less than 2" nominal thickness material; with depth as required for proper structural support of the work.

2.04 ENGINEERED WOOD – GENERAL:

A. **Standard:** APA “Engineered Wood Construction Guide”.

2.05 ENGINEERED WOOD – CONSTRUCTION PANELS:

A. Non-Structural Backing Panels:

1. **For:**

   a. Telephone and electrical equipment.

   b. Concealed supports for other work, e.g. exterior metal panels, equipment, fixtures, grab bars, etc.
2. **Veneer Grade**: APA C-D Plugged INT.

3. **Thickness**: 3/4”.

4. **Edge Detail**: Square.

### 2.06 RELATED MATERIALS:

A. **Anchorage Devices**:

1. **Mechanical**: Refer to Division 1 – Common Product Requirements - Fasteners & Anchors Section.

2. **Construction Panel Adhesive**: APA AFG-01 and ASTM D 3498; engineered for application of subfloor underlayment construction panels to structural framing supports and approved by Construction Panel and Adhesive Manufacturers for each application and each environmental exposure.

### PART 3 – EXECUTION

### 3.01 INSTALLATION, GENERAL:

A. **General**: Comply with ANSI/AWS “NDS for Wood Construction”.

B. **Spaced Framing**: 16” o.c.; unless otherwise indicated.

C. **Structural Plywood Sheathing**: Screw fasten panel long dimensions perpendicular to framing and metal deck ribs. Provide 1/8” space between abutting panel ends, 1/4” space at abutting panel edges and where similar space wherever ends or edges abuts adjacent work.

D. **Anchorage**: Screw fasten or bolt members to adjacent steel members.

E. **Accuracy and Fit**: Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Scribe and cope as needed for accurate fit.

F. **Topical Treatment**: Treat all untreated surfaces of field cut pressure treated wood members in accordance with AWPA M4, Authority standards, and Treatment warrantees; by brush, dip, or spray treatment methods.

END OF SECTION
SECTION 06640 – PLASTIC PANELING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Fiberglass reinforced plastic (FRP) wall panels.
B. Related Sections:
   1. Division 1 Sections.
   2. Division 4 – Concrete Masonry Units.
   3. Division 9 – Metal Support Assemblies.
   4. Division 9 – Gypsum Board.

1.03 SUBMITTALS:
A. Product Data: For each material, submit available published Project related data and performances.
B. Shop Drawings: Submit as required for proper fabrication and installation of units, e.g., each layout, details of components and anchorage coordinated with adjacent work.
C. Samples:
   1. Panels: Submit 8-1/2” x 11” samples for review of each texture.
   2. Trim: Submit profile x 11” lengths of each type of trim.
   3. Color and Texture Selections: Submit range of available color chips of same material as required for Project.

1.04 WARRANTY:
A. General: Refer to Division 1 requirements.

1.05 MAINTENANCE:
A. Maintenance Instructions: Submit care and maintenance instructions in accordance with Division 1 requirements.
2.01 WALL PANEL ASSEMBLY:

A. FRP-#

1. Product: One of following.
   a. Basis of Design: Marlite product as scheduled.
   b. Other Available Manufacturers: Subject to compliance with the requirements, preapproved equals from any of the following.
      1) Crane Composites, Inc.
      2) Glasteel.
      3) Kalwall.
      4) Graham.
      5) Nudo.

2. Type: Fiberglass reinforced plastic; polyester resin based.

3. Thickness: 0.090” minimum.

4. Texture and Colors: Panel Unit Manufacturer’s standard “embossed” texture; in standard colors to be selected by the University.

5. Size: Maximum size to minimize number of panel joints.

6. Primary Characteristics: Not less than following.
   b. Flexural Strength: ASTM D 790, 10.0 x 10^3 psi.
   c. Flexural Modulus: ASTM D 790, 3.0 x 10^5 psi.
   d. Tensile Strength: ASTM D 638, 6.0 x 10^3 psi.
   e. Tensile Modulus: ASTM D 638, 3.0 x 10^5 psi.
   h. Water Absorption: ASTM D 570, 0.72% maximum, at 24 hours; at 77° F.
i. ICBO Certification: Current.

ej. USDA/FSIS Compliance: Meets current requirements.

B. Related Materials: Panel Manufacturer’s standard components as follows.

1. Adhesives: Approved by Panel Manufacturer for each type of Project application required; selected to prevent delamination from each substrate type; under each installation and use condition.

2. Accessories:
   a. Trim: Molding trims as required for each terminating edge or panel to panel condition. Trim color to match trimmed adjacent panel.
   c. Other: Provide all related materials for accessories. Ensure that no terminating end conditions expose open ends and are closed with end caps.

3. Anchorage Devices: Plastic color matched drive rivets or stainless steel fasteners.

4. Sealant: Panel Unit Manufacturer’s recommended silicone sealant product.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verification of Conditions: Ensure substrates are in compliance with requirements, including tolerances.

B. Preparation: Acclimate panels to each installation space for Panel Unit Manufacturer’s recommended period. Remove deleterious materials from substrate.

3.02 INSTALLATION:

A. General: Comply with Panel Unit Manufacturer’s Project related requirements as fully submitted and successfully reviewed by the University; including for layout.

B. Panels: Apply adhesive with 100% coverage to each panel back. Ensure full bonding with substrate. Anchorage devices where not fully concealed, may be used only when approved by the University on Shop Drawings and only when no other method of installation is possible due to existing conditions of the installation.
C. **Trim**: Fully trim perimeters of each panel. Comply with Panel Unit Manufacturer’s required gaps at perimeter edges to allow for proper expansion and contraction of trims. Conceal fasteners.

D. **Base**: Provide in each area, unless other floor termination method indicated.

E. **Sealant Application**: Fully seal all edges/trim in conformance with Panel Unit Manufacturer’s requirements. At ceiling trim, at base, or trimmed outer edge, apply additional sealant behind trim prior to its installation to ensure that panels are fully sealed from moisture intrusion.

3.03 **DEFECTS, PROTECTIONS & CLEANING**:

A. **General**: Comply with Division 1 requirements.

END OF SECTION
SECTION 07051 – MOISTURE PROTECTION – COMMON WORK RESULTS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Common quality assurance measures required of moisture protection assemblies.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 7 – Vapor Retarders – Below Grade.
      3. Division 7 - Roof & Deck Insulation.
      4. Division 7 – Modified Bituminous Membrane Roofing.
      5. Division 7 - Flashing and Sheet Metal.
      6. Division 7 - Joint Sealers.

1.03 DEFINITION:
   A. Moisture Protection Assemblies: As used herein, is to mean all materials in an assembly that has as its primary purpose to be barrier that is used to manage ingress or egress, or both, of moisture in the form of water or water vapor, or both; including materials that may not be the primary barrier material, but which is part of the assembly and impacts the performance of the assembled barrier. Examples include roofing, waterproofing, curtain wall and storefronts, weather barriers, flashing and sheet metal work and joint sealant assemblies.

1.04 SUBMITTALS:
   A. Quality Assurance Submittals: Refer to "Quality Assurance" paragraphs herein.

1.05 QUALITY ASSURANCE – DESIGN INTENT:
   A. General: Specified requirements herein are required for all work whose function is moisture protection as defined herein, unless specific requirements are waived in the individual Specification Sections.
B. Waiver: Where any specific requirement is waived by an Individual Specification Section, such waiver does not relieve the Contractor from providing compliance with the Contract Intent.

1.06 QUALITY ASSURANCE - MANUFACTURER RESPONSIBILITIES:

A. Manufacturer's Qualifications: Submit written confirmation of following.

1. Production Experience: 10 years current and continuous experience manufacturing specified products for projects of similar scope.

2. Product Distribution: National minimum to all major regions in the U.S.

   
   a. Primary moisture protection materials.

   b. 70% minimum of all other related materials.

B. Manufacturer - Certifications: Submit written certifications for the following.

1. Activity Accomplished Prior to Installer's Contract for the Work: Confirm that Project selected Installer had contacted the Manufacturer in a timely manner and had fully informed the Manufacturer of all the Project requirements, e.g. moisture protection conditions, specified moisture protection systems, and Warranty requirements. Indicate date of contact, confirm appropriate Parties informed and confirm that the Manufacturer has no specific issues that would jeopardize providing the required systems for this Project.

2. Activity Accomplished Prior to Purchase and Manufacture of Project Products: Confirm that the Manufacturer has completed a full review of Contract requirements and that the Contract requirements comply with or that additional documentation modifying the systems were submitted and accepted by the Architect to ensure that the Project moisture protection systems meet the Manufacturer’s requirements for this Project.

3. Approval of System Materials: Approve all materials proposed by Installer for use in each system assembly. Submit list of approved materials by system and indicate where each can be used. Approved list is also to be submitted to the Contractor and Installer.

4. Adjacent Materials by Other Installers: For all materials by other Installers in contact with each Moisture Protection Manufacturer’s system materials, by provide written approvals as follows.
   
   a. Materials are not detrimental, e.g., cause damage and deterioration, to the moisture protection system materials.
b. Where any adjacent material has an impact on the moisture tightness of the membrane, indicate acceptance of method of transition. It shall be recognized that Manufacturer's "acceptance" is not an approval of the performance of the adjacent product, but only that it generally meets an acceptable way of providing a moisture protected transition between products.

C. Manufacturer - Technical Representative: When specified or where a "Manufacturing and Installation Defects" Warranty is involved, comply with the following.

1. **Assignment:** Assign qualified Manufacturer's Technical Representative for this Project.

2. **Observation Intent:** Visit the Site during each moisture protection system installation as required to assure proper installation of each moisture protection system and to certify each installed systems for specified Project Warranties.

3. **Installer Personnel Training:** Train each Installer's Project assigned Supervisor and personnel in Project specific installation requirements by Manufacturer's Technical Representative, just prior to installation. Submit list of each trained personnel, when training performed, length of training, and primary procedures covered.

4. **Third Party Review:** Secure an independent third party professional, in lieu of or in addition to, their Company's Technical Representative, which can act legally in their behalf for field review of their membrane systems with full legal authority to act and speak in behalf of the Moisture Protection System Manufacturer with regard to moisture protection issues where the Project systems cannot be monitored a regular, e.g. once each work week basis, in a manner to assure each work is being installed properly.

5. **Field Reports:** For each visit, submit written field report assessing each installation. The detailed field reports to indicate the date, the time, the length of time of each visit, the temperature of each day, the temperature of the substrate at the time of application, the application temperature, an evaluation of the installed work, documentation of any unqualified personnel performing work, corrections required (if any), corrections accomplished and any other important aspects affecting the success of the installation.

6. **Photographs:** For each visit, attach with each Field Report, high definition camera, electronic, photographs of properly installed and improperly installed work (if any), work at transitions, penetrations, and before and after photos of corrective work (if any).

7. **Distribution of Field Reports and Photographs:** Submit to the Contractor, Architect, the Owner, the Installer, the Manufacturer and
any other Parties that are affected by the content in the Reports and electronic files of the photographs on DVD.

D. Manufacturer’s Installation Instructions:

1. **Manufacturer Responsibility:** Prepare and submit detailed installation instructions specific for each Project system assembly and specific to each Project substrate and each Project substrate conditions.

2. **Installer and Installer’s Personnel Responsibility:** Each Project assigned Supervisor and personnel to fully read instructions and submit written certification that each has read and fully understands the Manufacturer’s submitted installation instructions in general and as specifically applies to his or her responsibility on this Project.

3. **Distribution:** Submit copies to the Contractor, Installer, the Architect, the Owner, and each Installer’s Project assigned personnel. Contractor and Installer to maintain additional copies at the Site at all times until successful completion of the moisture protection systems.

E. Coordination:

1. **Tolerances/Finish of Substrates:** Coordinate with other Installers providing substrates over which each moisture protection system is scheduled, the required tolerances, condition, and finish of the substrates necessary to ensure the success of each installation. Coordinate in timely manner to ensure that other Installers can implement requirements in accordance with the job schedule. Submit written documentation of this coordination including date of coordination, with whom coordinated, and requirements specified.

2. **Control Joints:** Control joints, if required, are indicated on the Contract Documents, where additional or other configuration for control joints required in substrates than what is currently required to ensure the success of each membrane installation, submit requirements to Architect for his review and arrange (pay for) with Substrate Installer the installation of such control joints at no additional cost to the Contract for the Work, after successful review of these joint configurations by the Architect.

3. **Ultraviolet Exposures:** Contractor and Installer to ensure that ultraviolet sensitive materials are not exposed beyond limits allowed by the Manufacturer.

4. **Preinstallation Conferences:**
   
a. **When Required:** Conduct as required to ensure proper coordination of all Parties impacting each moisture protection system installation.
b. **Notification**: Notify the Architect and Owner of each meeting when preinstallation conferences are to be conducted.

c. **Submittal**: Submit written minutes of each meeting. Record all parties invited and those who attended by name and company.

d. **Technical Representative**: Ensure that Technical Representative or Third Party Representatives, or both, are present at all meetings.

5. **Exposed Moisture Protection Material Coordination**:

   a. **Contractor Responsibility**: Contractor to coordinate his operations with Moisture Protection System Manufacturer to ensure that types of operations and equipment do not damage or deteriorate exposed membranes. Contractor to notify all Entities doing work over exposed membranes of types of operations and equipment that are allowed. Do not conceal any membrane prior to acceptance of membrane conditions by the Technical Representative.

   b. **Technical Representative Observation and Inspections**:

      1) During moisture protection assembly contract period, conduct observation and inspections at a frequency required to assure assemblies are being properly installed, but not less than once each work week.

      2) Conduct routine quality assurance inspections of each work to assure that each work is being properly installed. Attention to be paid to moisture intrusion sensitive work, e.g. terminations, penetrations, transitions, and flashings, and other performance sensitive work, e.g. wind performance sensitive.

      3) Conduct inspections of assembly components for damage and deterioration just prior to final operations to conceal each assembly component.

      4) Monitor operations which have potential for damaging or deteriorating any assembly components.

F. **Base Substrate Requirements**:

   1. **Preparation**: Waterproofing Installer to be responsible for complete substrate preparation of the existing conditions in conformance with Moisture Protection System Manufacturer's requirements.

   2. **Certification**: When a Technical Representative or Third Party Review, or both, is required, submit Moisture Protection System Manufacturer's Technical Representative's written certification of
compliance of prepared substrate in conformance with requirements necessary for each system installation. Certification of substrate to be accomplished just prior to each application of membrane system and before any contamination can occur.

G. Transitions Between Different Assembly Types: Where two different primary moisture protection system types must transition between each other, to ensure a continuous moisture protection system and whether such systems are by the same Moisture Protection System Manufacturer or by a different Moisture Protection System Manufacturer, the Moisture Protection System Manufacturer which is last to be applied at the transition, is the Moisture Protection System Manufacturer to warrant the bonding of that transition for the lifetime of its material.

H. Correction of Defects - Restrictions: Where correction of defects, e.g. deteriorated, damaged and improperly installed work, is required, comply with following. Submit written documentation of all of following.

1. Do not implement corrections without timely written notification of the Manufacturer, Technical Representative (when required by these specifications), Third Party Reviewer (when required by these specifications), the Contractor and the Architect.

2. Submit any required documentation that may be required by the Technical Representative and Third Party Reviewer.

3. Do not implement corrective actions without express written approval by the Manufacturer, Technical Representative (when required by these specifications) or the Third Party Reviewer (when required by these specifications).

4. Secure written approval by the Technical Representative (when required by these specifications) or the Third Party Reviewer (when required by these specifications) that the corrective action has been inspected and approved.

1.07 QUALITY ASSURANCE - INSTALLER RESPONSIBILITY:

A. Installer - Qualifications: Submit written documentation of following. All of following must be accomplished prior to Installer securing the Contract for the Work and prior to purchase and manufacture of any Project products.

1. Installation Experience: Installers of each Moisture Protection System to have not less than eight (8) current and continuous years experience successfully installing the Moisture Protection System Manufacturer's products or same generic systems of similar scope, installation complexity and moisture protection severity as required for this Project and with not less than three (3) current successful projects of comparable scope and installation complexity using the selected Project systems. Submit one (1) project that has been
installed for five (5) years or longer that has been installed successfully.

2. **Manufacturer Certifications and Approvals:** Where the Moisture Protection System Manufacturer maintains a Quality Assurance Training Program for Certification or Licensing, in general or specifically, for the Project moisture protection systems, or both, submit documentation, that the Installer has successfully completed all required training, not less than two (2) years prior to the time the Contractor has secured the Contract for the Work. Where the Manufacturer maintains such a Program the Installer must have successfully completed all such training to do this Project. If the Manufacturer does not maintain such Quality Assurance Programs, then only when acceptable to the Architect, may the Manufacturer submit a written approval that the Installer has the requisite experience and maintains the required experienced personnel to install the Project products in accordance with their Project specific requirements to meet the moisture protection system intent for this Project.

**B. Installer - Personnel Qualifications:** Submit written documentation of following of each Project assigned personnel.

1. **Experience:** Five (5) years minimum moisture protection experience with not less than one (1) successful Project using Project specific products on project of similar scope, kind, and installation complexity and three (3) other successful projects indicating types of comparable moisture protection experience. Document each product system type installed for each project and specific installation responsibilities for each moisture protection system.

2. **Project Assignments:** Installer to submit written list of assignments for which each Project assigned personnel is competent at. Installer to certify in writing that he is qualified to perform each listed work for which he or she is assigned. On Assignment List, Installer to sign and certify that he has verified the competence of each personnel and is confident that each listed assignment for each personnel is appropriate for the level of competence necessary to achieve the moisture protection system intent for this Project in accordance with Moisture Protection Manufacturer's requirements as represented by detailed written Manufacturer's installation instructions for this Project.

3. **Restrictions:**
   
a. Do not use any personnel for which documentation above has not been provided prior to their start of any moisture protection system work on this Project.

b. Do not use any personnel on any procedure for which He or She is not competent at without constant supervision and until that person and the Installer can submit written confirmation that the
assigned personnel has achieved the level of competence necessary to accomplish the procedure in accordance with the Manufacturer's Project specific intent without any supervision.

4. **Definition - Competence**: "Competence" as defined herein with regard to any personnel assigned to do any Project specific moisture protection assembly installation work to mean that the personnel possesses the expertise necessary to accomplish each specific Project task as required to achieve the Contract performances for that task, including water tightness of each Project assembly in strict conformance with the Moisture Protection Assembly Manufacturer's requirements.

5. **Installer’s Supervisor's Qualifications**: Installer to assign a full time Supervisor with not less than 3 years current supervisory experience with similar Project systems and with not less than 2 comparable successful installations supervised by him. Submit qualifications.

C. **Installer - Field Reports**: For each application day, submit detailed written reports of application conditions important to quality of each installation, including following types of data.

1. Date of each application.
2. Times of application.
3. Superintendent present.
4. Technical Representative when present.
5. Assigned Project personnel specifically applying moisture protection materials.
6. Daily weather conditions, e.g. temperatures, humidity, degree of rainfall, at time of each application.
7. Any detrimental environmental and substrate conditions that affects daily installation conditions at time of each application and corrective measures performed.
8. Substrate temperature and moisture readings.
9. For fluid applied materials, mils monitoring for any spray or fluid applied products.
10. Application rates.
11. Length of time between each material application where proper curing or timing between application is critical to performances.
12. Equipment gauge monitoring.
13. Kinds of ongoing and daily equipment cleaning performed.

14. Types of repairs done to damaged, deteriorated and other defective work.

15. High definition, electronic photos of each assembly component as it is being installed and after its completion. Photos to additionally include work at flashings, penetration work, other transition work and before and after photos of each corrective work.

1.08 QUALITY ASSURANCE - CONTRACTOR RESPONSIBILITY:

A. Contractor Responsibility - Ongoing Operations: Adjust operations to prevent any detrimental conditions that can damage and deteriorate installed moisture protection work, e.g. backfilling, types and weights of equipment, general construction traffic frequency, and types of construction traffic, including degree, extent and duration of imposed detrimental conditions.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Refer to each affected product system as specified in the individual Specification Sections.

PART 3 - EXECUTION

3.01 GENERAL:

A. Refer to each affected product system as specified in the individual Specification Sections.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Water repellents based on silicone hybrid chemistry.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 3 - Cast-In-Place Concrete.
      3. Division 4 – Concrete Masonry Units.
      4. Division 7 – Moisture Protection – Common Work Results.
      5. Division 7 - Joint Sealers.

1.03 SUBMITTALS:
   A. Product Data:
      1. General: Submit available Manufacturer's available product data.
      2. Including:
         a. All tested performances, including those indicating compliance with specified requirements. Where not clear, indicate whether tested performance Manufacturer test or independent laboratory certified.
         b. Project specific, Manufacturer recommended, mix and application rates for each Project substrate to be treated.
         c. Approved equipment.
         d. Detailed installation instructions.
         e. Project specific treated substrate preparation requirements.
         f. Protections required of adjacent materials.
g. Manufacturer Project specific restrictions, if any, that are not otherwise indicated in standard submitted Project data and in which Installer would not be aware of.

B. Quality Assurance Submittals: Refer to “Quality Assurance” paragraphs herein.

C. Field Quality Control Submittals:
   1. General: Refer to "Field Quality Control" paragraphs herein.
   2. RILEM Target Test Results: Prior to start of any RILEM field tests, submit Manufacturer's target test results to be achieved for each substate to ensure proper repellency of each of their products under installed Project conditions.
   3. Substrate approvals.

D. Closeout Submittals: Refer to “Warranty” and “Maintenance” paragraphs herein.

1.04 QUALITY ASSURANCE:

A. General: Manufacturer, Installer and Contractor to comply with Division 7 - Moisture Protection - Common Work Results Section, except that Third Party Reviewer need not be provided where Manufacturer submits in writing that Third Party review is not necessary to meet the Project intent, including for Warranty. Provide all submittals required under that Section.

B. Protection Plan: Submit plan necessary to fully protect adjacent work and landscaping from contamination and damage. Review of plan does not relieve Installer from protecting adjacent work from contamination and damage; which is solely his responsibility.

C. Coordination: Coordinate cleanliness of each substrate with installing Trades; over which water repellent materials are to be applied. For cleaning performed by Water Repellent Installer, secure written approval of Trades responsible for substrates for cleaning materials and methods to be used by Water Repellent Installer.

D. Mockup:
   1. Type: Prior to purchase, manufacture and installation of any Project product, construct 4’ x 8’ minimum, independent Project representative mockups of each substrate type scheduled to be water repellent treated. Mockups not to be part of the Work and located on Site. Mockup for CMU to be treated over entire surface with water repellent and 50% of surface with anti-graffiti coating.
   2. Subsequent Applied Materials:
      a. General: Apply subsequent final exposed materials to treated
substrates after RILEM testing completed for subsequent bond testing.

b. **Exception:** Typical sealants that are scheduled to be bonded to treated substrate to be applied to representative joints in base substrate across the width of each mockup prior to treatment of each mockup.

3. **Review Intent by Manufacturer's Technical Representative:**
   
a. **Substrate Preparation:** To observe substrate preparation quality.

b. **Application Rate:** To determine RILEM field quality control testing for appropriate water repellent application rates for each substrate and to ensure subsequent applied materials can properly bond to substrates.

4. **Review Intent by University:** To ensure that final applied materials do not change the appearance of the substrate, including at demarcation between water repellent only and anti-graffiti coating treatment application.

5. **Observation:** Coordinate observation by the University and Manufacturer's Technical Representative to occur at the same time, unless otherwise acceptable to the University.

1.05 **DELIVERY, STORAGE AND HANDLING:**

A. **General:** Refer to Division 1 requirements.

1.06 **WARRANTY:**

A. **Manufacturer's Warranty:** Submit Manufacturer's written and executed, "Manufacturing and Installation Defects" Warranty covering manufacturing and installation defects in materials and defects in the installation of the materials for a period of five (5) years from date certified for Substantial Completion.

B. **Installer’s Warranty:** Installer to submit a written and executed "Installation Defects" Warranty against installation defects in materials and their workmanship, including for performance of the water repellency of the work for period of two (2) years from date certified for Substantial Completion.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. **Basis of Design:** Subject to compliance with requirements, Manufacturer's specific products specified herein may be incorporated into the Work.
B. **Available Manufacturers:** Subject to compliance with requirements, pre-approved equal products from one of the following Manufacturers.

1. BASF Construction Chemicals.
2. Chemical Products Industries, Inc.
3. Chemprobe Technologies, Inc.

2.02 **WATER REPELLENT MATERIALS:**

A. **Primary Performance Characteristics:**

1. **Percent Active Performance Ingredient:** 40% minimum.

2. **Substrate Appearance:** No change in color or sheen to applied materials.

3. **Set 1:** Following set of tested characteristics based on a 24 hour minimum soak, otherwise Set 2 applies.
   a. **Water Absorption:** ASTM C 140, 95±5% average minimum reduction.
   b. **Moisture Penetration:** ASTM E 514; with 95±5% minimum reduction.

4. **Set 2:** Following set of tested characteristics, otherwise Set 1 applies.
   a. **Water Weight Gain:** NCHRP 244, 85±5% average minimum reduction.
   b. **Chloride Absorption:** NCHRP 244, 90±5% average minimum reduction, Series II or Series IV test; applied at 200 square feet per gallon maximum.

5. **Set 3:** Other tested characteristics may be suitable when the specified Basis of Design Product has same available performance test criteria; which is acceptable to the University.

6. **Penetration Into Substrate:** 0.20" minimum average.

7. **Effect on Subsequent Applied Finishes:** No effect and does not act as bond breaker to subsequent direct applied products that require bonding, e.g. paint coatings, plaster, tile, stone, or sealants, to the treated substrate.

B. **RPL-1:**

1. **For:** Water repellent protection.
2. **Manufacturer:** Evonik Degussa Corporation.
3. **Product:** "Chem-Trete 40 VOC".

4. **Chemical Type:** Isobutyltrialkoxysilane.

5. **Active Ingredient Content:** 50%.

6. **Carrier:** Solvent.

7. **VOC:** 590 g/l.

2.03 **RELATED MATERIALS:**

A. **General:** As required by Water Repellent Manufacturer to ensure proper application under each Project installation condition.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. **Condition of Substrates and Adjacent Work:** Have original Installers correct following.

1. **Defective Work:** Repair defective work, e.g., mortar joints, damaged masonry, defective sealed joints, etc. Do not apply water-repellents over uncured repaired work.

2. **Contaminated Work:** Remove contaminants from substrates.

3.02 **PREPARATION:**

A. **General:** Comply with substrate preparation submittals as fully submitted and successfully reviewed by the University.

B. **Protections:** Implement protection plan successfully reviewed in submittals by the University. Implement other measures as necessary to fully ensure protection of adjacent work and landscaping from contamination and damage to adjacent work.

C. **Cleaning:** Implement traditional cleaning of substrates with materials and methods approved by each substrate Installer and in strict conformance with Water Repellent Manufacturer’s requirements. Do not water blast surfaces; except as allowed by Water Repellent Manufacturer. Remove efflorescence, and neutralize mold and mildew. Cleaning methods to comply with following.

1. ASTM D 5703, Preparatory Surface Cleaning for Clay Brick Masonry.

2. ASTM D 4258, Surface Cleaning Concrete for Coating.

3. ASTM D 4262, Test Method for pH of Chemically Cleaned Concrete.
D. **Environmental Conditions:** Apply water repellents under environmental conditions acceptable to Water Repellent Manufacturer specific to Project conditions.

3.03 **FIELD QUALITY CONTROL - PRIOR TO START OF THE WORK:**

A. **Performance:** Manufacturer's Technical Representative with assistance of Installer to conduct field quality control measures as specified hereunder. Manufacturer's testing costs to be part of the Bid.

B. **RILEM Testing of Mockups:**
   1. **Intent:** Verification of application rates for each substrate.
   2. **Application:** Apply each water repellent to representative mockups at rates approved in submittals.
   3. **RILEM Testing:** Conduct RILEM tests of each water absorbable substrate, e.g. CMU, concrete and mortar and grout joints, that are treated.
   4. **Submittals:** Submit results of each Manufacturer test of each substrate and subsequent Project installation and application rate recommendations.

C. **Substrate Approval:**
   1. **Intent:** Ensure each substrate to be treated has been prepared in strict accordance with Water Repellent Manufacturer’s requirements as fully submitted and successfully reviewed by the University.
   2. **Submittal:** Approve each substrate just prior to application of water repellent work. Submit documentation of date, time and location of each substrate approval.

3.04 **APPLICATION:**

A. **General:** Comply with Water Repellent Manufacturer’s Project specific requirements for each substrate type and condition; as fully submitted and successfully reviewed by the University, including any subsequent “field quality control” adjustments. Observe the Manufacturer’s recommended coverage and application rates, but not less than required to attain required water repellent performances. Utilize Manufacturer’s required equipment and application techniques to secure even and proper saturation of each substrate.

B. **Substrate Condition:** Apply to dry substrates to ensure maximum penetration without loss of repellency; except if any “wet on wet” procedures have been prior approved for porous substrates and to ensure proper water repellent performances.
C. **Materials:** Do not dilute or add any materials not specifically allowed in writing by Water Repellent Manufacturer and then only under the conditions allowed, if any.

3.05 **FIELD QUALITY CONTROL - POST INSTALLATION:**

A. **Method:**

1. Water spray treated areas after treatments fully cured as required by Water Repellent Manufacturer.

2. Retreat deficient areas and retest deficient areas by water spray.

3. Ensure water spraying does not damage adjacent areas including erosion of landscaping or deterioration of finishes.

4. Conduct RILEM testing, if required, by Manufacturer’s Technical Representative. Initial costs to be paid for by the Manufacturer. Additional Manufacturer testing of deficient areas until attainment of successful Contract compliance to be paid for by Installer unless otherwise acceptable to the Manufacturer. All costs for post field quality testing to be part of the original Contract Sum for the Work.

B. **Manufacturer's Technical Representative Responsibility:**

1. Be present at testing of each substrate.

2. Ensure testing and corrections performed to ensure Contract compliance and that each substrate can be warranted by Manufacturer.

3. Submit written reports of all testing.

3.06 **CLEANING AND TOUCHUP:**

A. **Cleaning:** Refer to Division 1 requirements. Remove water repellent materials from other work in timely manner as not to prevent permanent staining and damage to such surfaces. Methods of removal to not damage or deteriorate surfaces in any manner. Secure substrate Installer’s approval of methods where materials and methods prior to institution of any cleaning methods.

B. **Touch Up:** Just prior to Substantial Completion Inspection, touch up work where water repellent barrier has been damaged or reduced due to damages in substrates or due to repair of original damaged substrates. Do not accomplish touch up work until all intended repair work to substrates are complete.

C. **Damages:** Damaged adjacent work, if any, to be replaced or restored or both to not less than its original condition existing prior to start of water repellent work and to the satisfaction of the University.
3.07 SCHEDULE:

A. **RPL-1**: In addition to any other indicated surfaces, exterior exposed surfaces of cast-in-place surfaces where the concrete is the final exposed surface and not scheduled for any painting or any other protective subsequent finish, e.g. pedestrian trafficked concrete surfaces and precast sills.

END OF SECTION
SECTION 07210 – BUILDING INSULATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:

A. General: As specified in Section 01001.

1.02 SUMMARY:

A. Section Includes:

1. Fiberglass acoustical insulation.

B. Related Sections:

1. Division 1 Sections.
2. Division 5 – Cold-Formed Metal Framing.
3. Division 6 – Rough Carpentry.
5. Division 9 – Metal Support Assemblies.
6. Division 9 – Gypsum Board.

1.03 DEFINITIONS:

A. Cavity: As applicable to this Specification Section, word “cavity” refers to final built space fully enclosed on all sides with construction materials; in which insulation materials are required to be installed.

B. Hung Installations: As applicable to this Specification Section, words “hung installations” refer to insulation that is required to be installed in any position where gravity and air movement would otherwise cause it to move in any manner from its original position, e.g., slide, slump, fall out, and fall down, over time and reducing its required performances; unless devices or materials are provided to hold it in place. Examples of such installations include wire supported units and installations in vertical cavities that exceed the insulation dimensions and where the insulation can slump under gravity and or move due to air movement.

C. Loose Laid Installations: As applicable to this Specification Section, words “loose laid installations” are installations that are supported by board materials, e.g. plywood, gypsum board, or acoustical ceiling board, in a horizontal or sloping configuration where gravity and air movement do not cause the insulation to move in its loose laid position.
1.04 **SYSTEM DESCRIPTION – DESIGN INTENT:**

A. **Acoustical Performance:** Tested acoustical assemblies are not required. Insulation indicated is only for enhancement of the acoustical properties of the assemblies of which it is a part.

1.04 **SUBMITTALS:**

A. **General:** Submit in accordance with Section 01300 - SUBMITTALS.

B. **Product Data:** Submit Manufacturer’s standard published literature confirming Project requirements.

1.05 **QUALITY ASSURANCE:**

A. **Insulating Envelope:** For each type of performance, e.g., thermal and/or acoustical, provide insulation assemblies coordinated with other work performing similar functions and in manner to form a complete and continuous envelope around entire space or spaces for which each kind of performance is required.

**PART 2 - PRODUCTS**

2.01 **INSULATING MATERIALS – FIBERGLASS UNITS:**

A. **General:**

1. **Type:** ASTM C 665, Type I, unfaced fiberglass, blanket/batt units for thermal and acoustical units.

2. **Fire Hazard Classification:** ASTM E 84, flame spread 25 maximum, and smoke developed 50 maximum.

3. **Thickness:** 3-1/2” minimum for any single layer, but not less than required to comply with requirements herein.

B. **Acoustical Insulation Performance:** ASTM E 90 and ASTM E 413 tested products as required for acoustical performances, but not less than following thicknesses and weight.

1. **Wall Assemblies:** 4” minimum.

2. **Ceiling Assemblies:** 6” minimum.

3. **Weight:** 3 pcf.
C. Other Performances:
   1. Composite Performances: Where more than one type of performance required, e.g., thermal and acoustical or other, insulation to meet all required performances.
   2. Thickness: Where any assembly shows more insulation fill than required for Project performances, provide fill to the extent indicated; unless otherwise acceptable to University.

D. Available Manufacturers: One of following.
   1. CertainTeed Corp.
   2. Johns Manville Corp.
   3. Owens-Corning Fiberglass Corp.
   4. Or preapproved product.

2.02 RELATED MATERIALS:
A. Hung - Suspended Assemblies: Not required.
B. Anchorage Devices:
   1. General: Comply with Division 5 - Fasteners & Anchors Section.
   2. Impaling Anchors:
      a. Type: Type with integral perforated metal plate for adhesive installation; include self-locking washers, and fastener adhesive of type and viscosity as recommended by fastener manufacturer for type and conditions of installation and to ensure proper bond of fasteners to types of substrates indicated. Provide length to fit cavity depth.
      b. Available Manufacturers: Subject to compliance with the requirements, provide Goodloe E. Moore, Inc. GEMCO fasteners and TUFF-BOND/WELD adhesives or comparable products acceptable to University.

PART 3 - EXECUTION
3.01 INSTALLATION – GENERAL:
A. General: Comply with Insulation Manufacturer's Project related requirements. Extend insulation over entire area to ensure required insulating and acoustical performances. Cut and fit tightly around
obstructions, and fill voids with insulation. Remove projections which interfere with placement.

3.02 INSTALLATION – FIBERGLASS INSULATION:

A. Cavity Installations: For thermal or acoustical units, comply with following.

1. To 6” Depth: Friction fit units; full depth.

2. Greater than 6” Depth: When required to be fully filled with insulation, build up with additional layers. Where not required to be filled to full depth and not scheduled to be supported in place with other materials, comply with requirements for “hung installations, impaling pins” paragraphs.

B. Hung Installations:

1. Suspended: Not required.

2. Impaling Anchors: For thermal and acoustical units in cavities that exceed insulation thickness and are not loose laid installations, comply with following.

   a. General: Adhere pin flanges to solid surfaces. Space pins in manner to fully support insulation in place. Impale insulation over pins and apply pin clips snug against insulation; without crushing insulation. If pin extension interferes with subsequent installed work and where pin is installed in people accessible spaces, e.g., attics, clip pins as short as possible and blunt pointed edges. Blunted edges not to interfere with future removal of pin clips.

   b. For Vertical Cavities: Where insulation is not full depth, e.g., 4” insulation is required in 12” depth cavity, impale with pins at 6” o.c. across top end of insulation.

   c. For Horizontal Cavities: Impale pins at 12” o.c. maximum at perimeters and in field of each unit to prevent sagging. Adhere pins to solid surfaces.

C. Loose Laid Installations: Lay insulation monolithically over required horizontal substrates. Do not leave gaps between adjacent butting units.

3.02 INSTALLATION – REFLECTIVE INSULATION UNITS:

A. Layout: Install each unit in direction required by Manufacturer to achieve maximum insulating performance for each installation condition as fully submitted and successfully reviewed in submittals by University. Mechanically fasten units as required to hold in place. Observe proper configuration of insulation.
B. **Laps:** Tightly butt or lap succeeding adjacent rows and continuously tape all joints between units and to adjacent terminations.

END OF SECTION
SECTION 07220 – ROOF & DECK INSULATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Roof deck Insulation assembly.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 7 – Common Work Results - Moisture Protection.
      3. Division 7 – Modified Bituminous Membrane Roofing.
      4. Division 7 – Flashing & Sheet Metal.

1.03 SYSTEM DESCRIPTION:
   A. Adhesive Bond: As required to attain total roof assembly wind uplift performance as specified in Division 7 – Modified Bituminous Membrane Roofing Section.

1.04 SUBMITTALS:
   A. Product Data: Submit complete and detailed technical and performance data applicable to each Project installation; include material data, fire and wind assembly performances, drawings, specifications, installation instructions, and material and usage precautions.
   B. Shop Drawings: Submit Shop Drawings indicating Project specific details which are critical to each assembly, including but not necessarily limited to, primary insulation board requirements, layout, perimeter conditions, transitions/terminations, details at drains, and other penetrating elements.
   C. Samples: Submit following.
      1. Typical Membrane: 8-1/2" x 11" samples bonded of full system bonded with required adhesive to 1/2" minimum plywood board with typical seam.
      2. Typical Penetration: Submit on 8-1/2" x 11" plywood with pipe, replicate a typical pipe penetration membrane assembly.
D. Quality Assurance Submittals: Refer to "Quality Assurance" paragraphs.

1.05 QUALITY ASSURANCE:

A. Single Source Responsibility: Where roof and deck insulation is shown as part of a warranted total roof membrane assembly, comply with the following.

   1. Provide each insulation type as required for each installation assembly from or approved by the Product Manufacturer.
   
   2. Comply with Division 7 – Moisture Protection – Common Work Results Section.

B. Quality Assurance for Adhesive Application:

1. Adhesive Manufacturer’s Certification: Submit written certification that adhesive is not deleterious to bonded products in any way and that adhesives can develop full bonded strengths in accordance with Project requirements.

2. Installer Certification: Submit Adhesive Manufacturer’s written approval of Insulation Installer as capable of installing required adhesive products in strict conformance with their specific requirements for Project.

3. Training: Adhesive Manufacturer to provide qualified trainer to instruct Project assigned personnel of Insulation Installer in correct application of adhesive for each specific Project assembly. Submit written and dated documentation confirming such training from Trainer.

4. Equipment & Installation Procedures: Insulation Installer to utilize equipment and installation procedures specifically recommended by Adhesive Manufacturer for Project.

5. Insulation and Roofing Manufacturers’ Review: Secure and submit written documentation from Insulation Manufacturer and each Roofing Manufacturer that Project assemblies meet their requirements for the Project, including where system warranties are required.

6. Mechanical Fastened Systems: Mechanical fastening may be allowed only when preapproved and only to a limited extent so that the majority of the system remains adhesively bonded.

C. Coordination: Coordinate joint preinstallation conferences with each Roofing Installer as required under roofing specification sections, prior to installation of any insulation assemblies, to assure proper installation of Project assemblies.
D. **Insulation Thickness:**
   1. No insulation to be less in thickness at any point than acceptable to the Roofing and Insulation Manufacturer. Submit acceptable minimum thickness for the Architect's review.
   2. The thickness of insulation may be reduced from the specified minimum, when written documentation is provided for additional R-Value contributions of the other components making up each assembly.

E. **Adhesive Manufacturer Approval:** Where specified adhesive products are not acceptable to Roofing Manufacturer, notify Architect prior to Bid and submit Manufacturer acceptable product for review and acceptance for inclusion in Project.

1.07 **WARRANTY:**

A. **System Warranty:** Where the insulation assembly herein is part of another Moisture Protection System, include as part of that Product System Warranty.

B. **Special Warranty:** Adhesive Manufacturer to warrant bonding capability and specified performances for period 10 years from date established for Substantial Completion of Project.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURER:**

A. **Available Manufacturers:** Refer to Division 1 requirements.

B. **Acceptable Manufacturer's Products:** Design is based upon Manufacturers' products specified herein. Subject to compliance with requirements, these products may be incorporated into the Work.

2.02 **INSULATION BOARD:**

A. **Configuration:**
   1. Flat boards.
   2. Tapered boards.

B. **Types:** One of following as required by the Roofing or Waterproofing Manufacturer, or both, for Project specific assemblies.
   1. **R-Value, Typical:** 15 minimum, based on 75° F, PIMA Technical Bulletin 101 aged value and ASTM C 518.
a. **Flat Boards:** Single constant thickness as needed to achieve specified R-value.

b. **Tapered Boards:** Tapered thickness as needed to achieve specified R-value as an average over insulated area.

2. **Polyisocyanurate:**
   b. **Facer:** Unfaced.
   c. **Density:** 2 pcf nominal.
   d. **Compressive Strength:** ASTM D 1621, Procedure A, 20 psi minimum.
   e. **Dimensional Stability:** ASTM D 2126, 2% maximum linear change, at 158°F, 97% RH, and 7 day exposure.

3. **Expanded Polystyrene (EPS):**
   a. **Standard:** ASTM C 578, Type VIII, 1.25 pcf density.
   b. **Facer:** Unfaced.

2.03 **RELATED MATERIALS:**

A. **Adhesive:** As approved by the Division 7 - Bituminous Membrane Roofing Manufacturer for each Project specific roof assembly.

B. **Underlayment Fire Barrier Board:**
   1. **Material:** ASTM C 1177, silicone treated core gypsum board.
   2. **Fire Assembly:** Board to comply with requirements of Authorities for fire assembly required, including for thickness.
   3. **Thickness:** As required to comply with following.
      a. Windload performances.
      b. Fire assembly.
      c. Strength to properly span flutes per Manufacturer’s requirements.
   4. **Product:** Georgia Pacific “Dens-Deck”.

C. **Overlay Board:** Subject to same requirements, “Dens-Deck” product as specified herein.
D. **Tape:** As approved by Insulation Board Manufacturer for protection of insulation materials from roofing materials scheduled for application over each installation.

**PART 3 - EXECUTION**

3.01 **PREPARATION:**

A. **Verification of Conditions:** Refer to Division 1 requirements.

B. **Cleaning:** Just prior to installation, clean substrates of all deleterious materials and minor projections.

3.02 **INSTALLATION:**

A. **General:** Install in accordance with Adhesive and Insulation Manufacturer's coordinated Project requirements applicable to each installation condition as fully submitted and successfully reviewed by Architect. Assembly from base substrate up to be as follows.

1. Underlay fire barrier board, adhesively applied to base substrate.
2. Insulation, adhesively applied over underlay fire barrier board.
3. Overlay board, adhesively applied on Insulation.

B. **Adhesive Application:** Using proper equipment, apply primer and adhesive separately at coverage/application rates and curing times required by Adhesive Manufacturer. Apply adhesive to attain proper bonding of each component and performances of entire assembly.

C. **Insulation Application:**

1. **General:** Set board units into adhesive immediately after applying adhesive. Do not allow adhesive to skin over or set to degree that full bonding strength cannot be attained.
2. **Layout:** Stagger in conformance with Insulation and Roofing Manufacturer’s requirements.
3. **Tolerance:** Loosely butt insulation without any gaps in excess of 1/4". Fill gaps between insulation greater than 1/4" with same insulation used as a filler.
4. **Tapered Insulation:** Install in pattern shown on Shop Drawings to attain required slopes.
D. **Overlay Board Application:** For installations receiving subsequent roofing membranes, apply overlay board in staggered manner that joints of primary insulation board below do not align. Offset to be not less than 6" in each direction with board insulation below.

E. **Taping:** Fully tape all joints in overlay boards.

3.03 **PROTECTIONS:**

A. **Inclement Weather:** Coordinate installation with each primary roofing material Manufacturer to ensure that insulation installations are fully protected from damage from inclement weather. Install only as much insulation that can be covered by primary roofing material in a day or before onset of inclement weather.

B. **After Completion:** Verify types of construction operations that are to occur that could damage installations. Coordinate responsibilities with Contractor. Provide protections necessary to assure that installations are without damage at time certified for Substantial Completion.

3.04 **SCHEDULE:**

A. **Underlayment Board:** Provide under following conditions.
   1. If it is required as part of any fireproofing assembly.
   2. If it is required by the Roofing Manufacturer for any assembly.
   3. When otherwise shown.

B. **Overlayment Board:** Provide under following conditions.
   1. Over rigid insulation, when insulation needs protection from roofing system materials.
   2. Over rigid insulation, when overlayment board is required by roofing system.
   3. When otherwise shown.

C. **Insulation:** For low slope roofing installations as specified in Division 7 - Thermoplastic Membrane Roofing Section.

**END OF SECTION**
SECTION 07240 – EXTERIOR INSULATION & FINISH SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. DEFS systems.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 3 – Cast-In-Place Concrete.
      3. Division 4 – Concrete Masonry Units.

1.02 DEFINITIONS:
   A. General: ASTM E 2110, Standard Terminology for EIFS, except as otherwise modified by the definitions specified hereunder.
   B. Acronyms: Following are typical acronyms used.
      1. DA: "Direct Applied" finish systems; same as a DEFS.
      2. DAFS: "Direct Applied Finish Systems"; same as DEFS.
      4. DPR: "Dirt Pickup Resistant".
      5. EIFS: "Exterior Insulation and Finish Systems".
      6. EIMA: "EIFS Industry Members Association".
      7. EPS: Expanded polystyrene.
      8. MD: "Moisture Drainage".
      9. EIMA EIFS System Types by Insulation Type Used:
         a. Class PB: "Polymer Based" EPS systems.
         b. Class PI: "Polyisocyanurate Insulation" systems.
c. Class PM: "Polymer Modified" XEPS systems.

10. PMR: "Proven Mildew Resistance".

11. XEPS: "Extruded Polystyrene"

1.03 SYSTEM DESCRIPTION - TYPICAL ASSEMBLIES:

A. General: Typical assemblies indicated hereunder is listed in order from the base substrate up.

B. DEFS:

1. Base coat used as a leveling and sealing coat.

2. Moisture barrier.

3. Primer.

4. EFS finish coat.

1.04 SYSTEM DESCRIPTION - SYSTEM (FULL ASSEMBLY) PERFORMANCES:

A. System Performances: All systems to comply with or exceed the requirements of the following.

1. General:

   a. ASTM E 2321: Standard Practice for Use of Test Methods E96 for Determining the Water Vapor Transmission (WVT) of EIFS.

   b. ASTM C 1481: Standard Guide for use of Joint Sealants with EIFS.


   d. ASTM E 2359: Standard Test Method for Field Pull Testing of an In-Place EIFS Clad Wall Assembly. (For existing EIFS installations).

2. DEFS:

   a. ASTM C 1516: Standard Practice for Application of DEFS.

   b. ASTM C 1535: Standard Practice for Application of EIFS Class PI.

B. Weather Performances: In accordance with "System Performances" standards which includes the following.

1. Weathering, Accelerated.

3. Water Penetration.

4. **Water Vapor Transmission**: Per standards, except the following restriction to apply.
   a. **Typical**: All components to be 10 perms minimum or greater.
   b. **Exception**: Rigid insulation to be 5 perms per inch minimum or greater.

5. Mildew Resistance.


C. **Weather Performance – Special**: Finish coat of each system to incorporate self-cleaning technology discovered and patented by German Botanist, Wilhelm Barthlott who named the phenomenon the “Lotus Effect”.

1.05 **SYSTEM DESCRIPTION - COMPONENT PERFORMANCES:**

A. **Common Characteristics:**

1. **Surface Burning**: ASTM E 84, Class A or I.

2. **Bond**: Refer to System Description - Assembly Performances paragraphs.

B. **Weather Barrier**:

1. **General**: Meets ICC ES AC 212 requirements, including for following.
   b. Tensile bond.
   c. Water vapor transmission, except not less than perm rating as specified herein.
   d. Water resistance.
   e. Water penetration.
   f. Weathering for UV exposure, accelerated aging and hydrostatic pressure.

2. **Air Performance Related**: Results as tested by the Manufacturer based on the following tests.
   a. **Permeance**: ASTM E 2178; with a permeance of 10 perms minimum.
3. **Compound Stability**: If weather barrier is susceptible to flow, then ASTM D 5147, Section 15, 350° F performance.

4. **Nail Sealability**: If fasteners are required for any components, then ASTM D 1970, no water penetration at 5" of head for 3 days at 40 ° F.

C. **Reinforcing Mesh**:

1. **Alkali Resistance**: ASTM E 2098.

1.06 **SUBMITTALS**:

A. **Product Data**:

1. **General**: Submit EIFS and Gypsum Board Sheathing Manufacturer's standard Project related technical data, tested performance data, applicable standard details, installation instructions and the EIFS Manufacturer's Project specific requirements that are not indicated or deviates from their standards.

2. **Tested Performances**: In addition to any other test data to show compliance with requirements, submit test criteria and test results to show compliance with testing required in all of the following.

   a. ASTM E 2568.

   b. ASTM E 2570 and ASTM E 2273.

   c. ICC-ES AC 235.

   d. ICC-ES AC 212.

B. **Shop Drawings**: Submit drawings necessary for proper installation of EIFS work. Key details to plans, sections, and elevations. In addition to other required drawings show following.

1. Details at terminations and joints in each work.

2. Reinforcement details at movement sensitive areas, e.g. at panel joints, at outside/inside corners, at terminations, openings, and penetrations.

3. Details related to the weather barrier at terminations, penetrations and openings.

C. **Samples**:

1. **EIFS Samples**: For each color/texture required, comply with following.
a. Format:

1) **Construction:** For each system type provide a sample of each system with each required material layer and expose 1" x 8-1/2" wide band of each layer on an 8-1/2" x 11" Project required gypsum board substrate.

2) **Data:** Record formulations and methods for attaining each color/texture on each sample.

b. **Samples for Initial Architect Review:** Submit single samples replicating each custom color and texture matching Architect's specified requirements. Adjust color/texture, if required, and resubmit single samples until satisfactory representative samples attained.

c. **Final Samples:** Submit final samples replicating successfully reviewed initial sample in accordance with Division 1 requirements.

2. **Sealant:** Submit 1/2" wide x 6" long beads set in channels matched to each coating color required.

D. **Quality Assurance Submittals:** Submit in conformance with "Quality Assurance" paragraphs herein.

E. **Closeout Submittals:** Refer to "Quality Assurance" and "Warranty" paragraphs herein.

1.07 **QUALITY ASSURANCE:**

A. **General:** Comply with requirements specified in Division 7 - Moisture Protection - Common Work Results Section, except Third Party review is not required.

B. **Coordination:**

1. **General:** Coordinate base substrate tolerances and preparation with other Trades over which EIFS are to be installed to ensure proper installation of the work. Inform Trades in timely manner.

2. **Telegraphing:** Coordinate the work to prevent telegraphing of subsurface conditions of EIFS installations through final finish under any lighting conditions, e.g. fasteners, gypsum sheathing panel joints, and joints and textures of other substrates. Contractor to conduct coordination meetings. Submit methods agreed to between parties to prevent subsurface telegraphing.

C. **Tolerances:** EIFS Manufacturer's requirements but not to exceed following.

1. **Concrete Masonry Units:** Tolerances required by Division 4 - Concrete Unit Masonry Section.
D. **Additives:** Do not add any materials to modify EIFS products, unless otherwise published in written product data that is specific to Project conditions. Where published data is not available, submit written acceptance from EIFS Manufacturer that considered additives are acceptable to them for Project.

E. **Joint Sealant Installer:** EIFS Installer to secure a qualified Joint Sealant Installer with not less than five (5) years current and continuous experience in weather sealing EIFS projects of similar scope, installation complexity; with types of sealants required for this Project. Submit Installer’s experience.

F. **Contractor’s Responsibilities – Staining of EIFS:** Institute necessary precautions to protect the finished installation from any permanent staining which is prevalent at site and surrounding area during Construction Period. Precautions to be maintained until date certified for Substantial Completion. Unacceptable staining of EIFS work to be replaced at no cost to the University and in manner satisfactory to the Architect. Replacement work to be by original EIFS Installer.

G. **Restrictions:** Notify Architect where any of following occurs.

1. Color selected for any component has an LRV (Light Reflectance Value) of less than 20% where applied color is expected to cause temperature to exceed EPS service temperature, e.g., 160º F.

2. Any system is terminated above a surface that may be exposed to water, e.g. 8" at grade and 1" at adjacent pedestrian trafficked surface, that is not approved by the EIFS Manufacturer.

3. Any weather exposed horizontal or nearly horizontal portion of any work is not sloped in accordance with the EIFS Manufacturer’s requirements, e.g. 6:12 slope. Exception may be when surface is treated with a waterproof coating or other waterproofing method acceptable to the EIFS Manufacturer.

1.08 **WARRANTY:**

A. **Verification of Conditions of each Warranty:** Prior to execution of any final contracts for the Work with Installer and each Manufacturer which is required to submit warrantees for the Work and prior to the purchase of materials and their fabrication, following to be accomplished.

1. **Submittals:** Submit unexecuted copies of each required warranty. Submit prior to Owner and Architect Meeting.

2. **Final Executed Warrantees:** At time of Project Closeout, submit executed warranties as approved by Owner.

B. **Installer's Installation Warranty:** Submit written and executed “Installation Defects Warranty” covering labor and materials costs for replacement of
installation defects not covered by EIFS Manufacturer’s Warranty for period of two (2) years from date established for Substantial Completion; including watertightness of installed systems.

C. EIFS Manufacturer’s Warranty: Submit written and executed Manufacturer’s standard “Manufacturing Defects” Warranty covering labor and materials costs for replacement of manufacturing defects in installed materials for period of twelve (12) years from date established for Substantial Completion.

PART 2 - PRODUCTS

2.01 EIFS SYSTEMS:

A. DEFS Systems: Subject to compliance with requirements, systems of one following EIFS Manufacturers may be incorporated into the Work.

1. Basis of Design:

   a. Sto Corporation “Stolit Lotusan” DEFS.

   b. CMU and Concrete Substrate Assemblies: From substrate forward as follows.

      1) Skim Coat: BTS Plus or BTS Xtra for a leveling skim coat.

      2) Moisture Barrier: Sto Gold Coat system.

      3) Primer: StoPrimer Sand 801 (80801 product number).

      4) Finish Coat: Stolit Lotusan. Verify and provide 1.0 or 1.5 texture as selected by the University.

   c. Gypsum Board Substrates: From substrate forward as follows.

      1) Base Coat: BTS Plus; with mesh reinforcement.

      2) Finish Coat: Stolit Lotusan. Verify and provide 1.0 or 1.5 texture as selected by the University.

2. Subject to compliance with the requirements, when Products for each component are comparable to the "Basis of Design" products, one of the following Manufacturers may be incorporated when their products are accepted as a preapproved equals.

   a. Dryvit.

   b. Parex.
2.02 PRIMARY EIFS MATERIALS:

A. **Base Coats**: Manufacturer’s standard 100% acrylic modified, portland cement base coat.

B. **Reinforcing Fabric**: EIFS Manufacturer’s published “standard” mesh product, complying with ASTM D 578/579 or EIMA 101.86, open grid weave, alkali resistant, fiber glass fabric; complying with following EIMA Impact Ranges as follows.

   1. **Medium**.

C. **Moisture Barrier**: One component fluid applied, vapor permeable, spray-applied membrane with a ASTM E 96 perm rating of 5.0 minimum.

D. **Primer**: Manufacturer’s approved primer to assure bond between the moisture barrier and finish coat.

E. **FC-1, Finish Coat**: Specialty finish coat in University selected texture and in custom color as selected by the University. Texture to be created by selected size, sound aggregate particles, and fillers. Aggregates not to contain ferrous products.

2.03 SUBSTRATE MATERIALS:

A. **Masonry**: Concrete and CMU as indicated and provided by other Installers.

B. **Fiberglass Faced Gypsum Sheathing**: ASTM C 1177, 5/8” thick, Georgia Pacific “DensGlass Gold Fireguard”, Type X, including fasteners as required to meet Project wind loading based upon ASTM E 330 testing data. Provide fiberglass tape and chemical setting joint compound or other joint treatments as required by EIFS Manufacturer.

C. **Insulation Board**: ASTM E 2430 and ASTM C 578, Type I, 1 pcf minimum, expanded polystyrene board with thickness as indicated, but not less than 1”.

2.04 RELATED MATERIALS:

A. **General**: Provide related materials for the base coat, moisture barrier, primer and finish coat when required by the EIFS Manufacturer for each Project specific condition to assure proper installation of the Project materials and overall system performance of the final assembled coatings.

B. **Supports**: Provide additional metal supports complying with Division 9 – Metal Support Assemblies Section for following.

1. As required to support all Gypsum Board Sheathing panel edges and as otherwise required for windload performances. Kind, size, gage, and finish of framing to be similar to adjacent framing, unless otherwise acceptable to Architect.
2. As required to support penetrations through EIFS. Hot dipped galvanized straps alone may be provided; where such straps can be anchored to adjacent existing framing in manner to prevent vibratory movement of penetrations and without restriction of expansion and contraction of such supported penetrations.

C. Joint Sealer Materials: EIFS Manufacturer's approved materials as follows.


2. Joint Sealant: Dow Corning 790 silicone sealant or GE equivalent acceptable to Architect. No other products allowed. Custom color to be selected by Architect.

D. Penetration Filler: EIFS Manufacturer's recommended expanding urethane foam.

E. Trims: ASTM D 3678, PVC trims designed for EIFS/EFS systems. Provide Plastic Components, Inc. "VinylTech" trims as published in EIFS/EFS Manufacturer's standard details applicable to Project and as otherwise required to properly terminate EIFS/EFS assemblies. Products include, but are not necessarily limited to following.

1. Corner beads.

2. Casing beads.


F. Water: Potable and non-deleterious to materials being used with it.

G. Primers: If required by EIFS Manufacturer for specific Project assembly conditions, provide additional recommended substrate and intermediary primers to ensure proper bonding of each coating component.

PART 3 - EXECUTION

3.01 GENERAL:

A. Comply with requirements as fully submitted and successfully reviewed by the Architect. No installation to be less in quality than indicated in EIMA's publication "Guide to Exterior Insulation & Finish System Construction".

3.02 EXAMINATION:

A. Tolerances: Ensure each substrate tolerances meet the EIFS Manufacturer's requirements to ensure following.

1. Ensure each substrate are flat and free of projections.
2. Ensure substrate planes are true to planar location, level and alignment, e.g. not greater than 1/4" in 10'-0".

B. Substrate Conditions: Ensure all of following is in strict accordance with EIFS Manufacturer’s Project specific requirements.

1. Adhesive Bond: Ensure substrates are free of deleterious materials that can affect adhesive bond of subsequent EIFS materials.

2. Moisture Content: Test each moisture retaining substrate for deleterious levels of moisture. Do not install materials over moisture levels that are not approved by the EIFS Manufacturer.

3.03 PREPARATION:

A. Patching: Patch minor defects in concrete and masonry substrates.

B. Framing: Install additional framing where any end joints and edge joints would not otherwise have any framing for anchorage.

3.04 TRIMS:

A. General: Apply trims to corners, terminations, and drip or venting or both conditions over any base substrate.

3.04 GYPSUM BOARD BASE SUBSTRATE INSTALLATION:

A. General: Install in accordance with Gypsum Board Manufacturer’s requirements for EIFS type systems and which are acceptable to EIFS Manufacturer.

B. Board Orientation: Install staggered gypsum board sheathing in accordance with EIFS and Gypsum Board Sheathing Manufacturer’s requirements over building paper and to metal supports beneath. Ensure all board ends on framing are fully supported by framing members.

C. End Joints: Minimize end joints to greatest extent possible.

D. Fit:


2. Adjacent Abutting Construction: Provide following joint sizes.

   a. Nonmoving Joint: 1/4”.

   b. Moving Joint: 1/2” or as otherwise acceptable to Architect.

E. Anchorage: Anchor panels with required anchorage devices, at spacing, and pattern required to attain Gypsum Board Sheathing Manufacturer’s engineered wind load performances.
F. **Openings**: No joints are allowed within 8" of corners of openings. Cut each gypsum board panel to form an L-shape and install around each corner of an opening conforming to EIFS and Gypsum Board Sheathing Manufacturers' Project requirements.

### 3.05 DEFS COATINGS INSTALLATION:

A. **General**: Comply with EIFS Manufacturer's Project specific instructions.

B. **Skim Coat**: For CMU or concrete, apply skim coat and level surface as required from 1/16" minimum to 1/8" maximum thickness.

C. **Insulation**: Adhere insulation trim and other indicated insulation boards to the skim coat or base coat. Provide backwrapped mesh.

D. **Moisture Barrier**: Apply moisture barrier over concrete and CMU surfaces to 10 mils minimum to 30 mils maximum. Ensure that thickness does not impede water vapor permeance of the membrane.

E. **Base Coat**:

1. **Each Coat Thickness**: 1/16" minimum or as required to level surface and as required to prevent telegraphing of surface conditions through exposed to view finish coats, e.g. telegraphing of reinforcements, gypsum sheathing joints, and concrete masonry unit mortar joints.

2. **Reinforcing Mesh**: Where applied over gypsum board substrates apply required mesh weights over entire base coat application.
   
   a. **General**: Fully embed layer of required weight reinforcement in center of each base coat thickness and cover monolithically over entire substrate. Observe Manufacturer’s required lapping. Back wrap at all insulation boards and terminations in gypsum sheathing work even when trim provided and in other locations when required by EIFS Manufacturer.

   b. **No Mesh**: No mesh is required DEFS on concrete or masonry substrates, except reinforce outside corners, where mesh is required to reinforce substrate, and as required to prevent telegraphing of subsurface conditions.

   c. **Transitions**: If different mesh weights are required, ensure proper transition between each so that final coatings do not telegraph thickness differences.

3. **At Trim**: Apply color coat over portions of trim that would otherwise be left exposed to view after final work completed.

F. **Primer Coat**: Over moisture barriers, apply primer to moisture barrier coating.
G. **Finish Coat:** Apply to 1/16" minimum thickness finish coat over fully cured primer and base coatings. Do not wrap finish coat onto back wrapped edges, unless approved by EIFS Manufacturer and Sealant Manufacturer.

3.06 **JOINT SEALERS:**

A. **General:** Install backer rod and EIFS Manufacturer's approved sealants in joints abutting adjacent construction in strict conformance with Division 7 - Joint Sealers and recommendations of compatibility tests. Custom colored sealants where exposed to view in each EIFS installation. Sealants concealed behind coating systems may be any standard color.

B. **Joint Size and Locations:**

1. **General:** Comply with Division 7 - Joint Sealers Section.
2. **Expansion Joints:** As shown, but not less than 3/4" width.
3. **3/4" Minimum:** Following may be reduced to 1/2" where allowed by the EIFS Manufacturer.
   a. Where substrate EIFS is attached to changes.
   b. Where EIFS system abuts a different material.
   c. Changes in primary surface plane direction.
   d. Terminations of the work at openings, e.g. doors and windows.
   e. Terminations of the work at penetrations.
   f. At each 75'-0" building elevation.

3.07 **POST INSTALLATION:**

A. **Defects, Cleaning, Protection:** Refer to Division 1 Sections.

END OF SECTION
SECTION 07262 – VAPOR RETARDERS - BELOW GRADE

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Plastic “water” vapor retarder assemblies.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 2 – Termite Control – SS Screen Barrier Systems.
      3. Division 3 – Cast-in Place Concrete.
      4. Division 7 – Moisture Protection – Common Work Results.
      5. Division 15 and Division 16 Sections.

1.03 SUBMITTALS:
   A. Product Data: Submit comprehensive Project related data for primary vapor retarder and related materials.
   B. Shop Drawings: Submit drawings necessary for proper fabrication of components and vapor-tight installation of all materials. Show sheet layout, seaming and mastic sealing, and relationships to adjacent construction.
   C. Samples: Submit samples of following.
      1. Primary Vapor Retarder: Each type required.
      2. Related Materials: If requested by the University, submit samples of tape and mastic materials.
   D. Quality Assurance Submittals: Refer to “Quality Assurance” paragraphs herein.
   E. Closeout Submittals: Refer to “Warranty” paragraphs.

1.04 QUALITY ASSURANCE:
   A. Installer Qualifications: Comply with all Installer requirements as specified in Division 7 - Moisture Protection - Common Work Results Section. Third Party
Review and Technical Representative is not required where Vapor Retarder Manufacturer submits in writing that either is not required to ensure proper installation of their products.

B. Contractor Responsibility: Coordinate following with Installer.

1. Base Substrate Work: Coordinate tolerances and compaction of subgrade and drainage fill.

2. Penetration Work: Coordinate vapor retarder penetrating elements so that proper sealing of vapor retarder can be accomplished. Contractor to provide proper spacing between adjacent penetrating elements so proper sealing can be accomplished.

C. Tested Characteristics: Primary characteristics of materials are to be ascertained from certified independent laboratory tests.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Product Protection: Deliver, store, and handle products in manner to protect it from damage and deterioration in strict accordance with each Product Manufacturer’s instructions.

PART 2 - PRODUCTS

2.01 PRIMARY WATER VAPOR RETARDER:

A. VPR-1 – Primary Characteristics:

1. Plastic Material: 15 mil minimum, polyolefin film. Other materials may be considered when meeting primary vapor retarder characteristics.

2. General Type: ASTM E 1745, Class A material.

3. Water Vapor Transmission: ASTM E 96, 0.015 perms maximum.

4. Puncture Resistance: ASTM D 1709, 2445 grams or as otherwise acceptable to the University.


B. Acceptable Products:

1. Stego Industries, LLC “Stego Wrap 15 mil Class A” vapor barrier.

2. Or preapproved equal.
2.02 RELATED MATERIALS:

A. Primary Characteristics:

1. **Water Vapor Transmission:** ASTM E 96, 0.025 perms maximum; all materials.

2. **Chemical Resistance:** Must be unaffected by typical chemicals in Project soils and concrete slab, e.g. typical fertilizers, alkalai, etc.

3. **Hydrostatic Pressure Resistant:** Must be capable of resisting typical under slab type hydrostatic pressures without detriment to seals.

4. **Adhesion:** Capable of providing hydrostatic seal to each type of substrate to which it is bonded, including adjacent construction; without failure.

B. **Seam Tape:** Manufacturer’s recommended compatible plastic, pressure sensitive adhesive tape for each primary water vapor retarder required. Where more than one type of tape applicable, provide best quality tape.

C. **Mastic:** Manufacturer’s recommended compatible mastic for each primary water vapor retarder required. Where more than one type of mastic applicable, provide best quality mastic for membrane and adjacent construction bond.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. **General:** ASTM E 1643 and Vapor Retarder Manufacturer’s Project specific installation instructions as fully submitted and successfully reviewed by the University.

B. **Primary Membrane Installation:**

1. **Examination:** Ensure base substrate and tolerances properly compacted and shaped.

2. **Layout Direction:** Vapor retarder longest dimension parallel with direction of pour.

3. **Adjacent Construction:** Lap in accordance with Manufacturer’s requirements.

4. **Seams:** Lap adjacent side and end laps 6” minimum. Clean seams of materials detrimental to tape bond. Continuously seal with Manufacturer’s tape.
C. **Penetrations:**

1. **Examination:** Ensure proper clearances between adjacent penetrating elements have been provided to ensure proper sealing of penetrations.

2. **Vapor Retarder Sealing:** Clean surfaces of materials detrimental to bonding of mastic. Seal each penetration with mastic. Ensure bonding of mastic to penetration surfaces and vapor retarder for complete sealing of each penetration.

3. **Termite Control Coordination:** Coordinate termite control work as specified in Division 2 – Termite Control – SS Screen Barrier Systems Section to ensure proper sealing of both work.

D. **Repair:** If any tears, damage, and deterioration occur to any part of vapor retarder assemblies, patch work in accordance with Vapor Retarder Manufacturer’s requirements to re-establish intended vapor retarder performances.

3.02 **SCHEDULE:**

A. **VPR-1:** Under concrete slabs on grade. Exterior walks and exterior driveways are not included.

**END OF SECTION**
SECTION 07550 – MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS:

A. General: As specified in Section 01001.

1.02 SUMMARY:

A. Section Includes:

1. Two ply modified bituminous membrane roofing system.

B. Related Sections:

1. Division 1 Sections.
2. Division 5 – Steel Deck.
3. Division 6 – Wood Treatment.
4. Division 6 – Rough Carpentry.
5. Division 7 – Moisture Protection – Common Work Results.
6. Division 7 – Roof & Deck Insulation.
7. Division 7 - Flashing & Sheet Metal.
9. Division 15 and 16 Sections work as it affects each roofing assembly.

1.03 DEFINITIONS:

A. Low Sloped Roof: Roofs with slope ≤ 2:12.
B. Steep Sloped Roof: Roofs with slope > 2:12.
C. SRI: Solar Reflectivity Index.

1.04 SYSTEM DESCRIPTION – TYPICAL ASSEMBLY:

A. System Type: SBS torch applied membrane system.

B. Assembly: Unless otherwise indicated the assembly descriptions below is from the primary roof membrane down to the base substrate.

1. Modified bitumen cap sheet torch applied to the modified bitumen base sheet.
2. Modified bitumen base sheet torch applied to the overlayment board.

3. Rigid overlayment board adhesively applied to the roof and deck insulation.

4. Roof and deck insulation adhesively applied to the vapor retarder.

5. Vapor retarder applied to the rigid underlayment board.

6. Rigid underlayment board mechanically fastened to the base substrate.

1.05 SYSTEM DESCRIPTION - PERFORMANCE REQUIREMENTS:

A. Performance Requirements:

1. Wind Load Pressure: Following are IBC 2006 requirements.
   a. Engineering: Wind pressures determined in accordance with ASCE 7 for field, perimeter and corner conditions, but not less than following values.
      1) Main Building:
         a) Field: 27 psf.
         b) Perimeter: 42 psf.
         c) Corner: 60 psf.
      2) Canopy:
         a) Field: 35 psf.
         b) Perimeter: 57 psf.
         c) Corner: 57 psf.
   b. Wind Load Criteria: Refer to Structural Drawings for basic wind speed, exposure and importance factor.

2. Assembly Performance: Each assembly to be constructed to meet a tested FM 4450 assembly for the required windloading of each assembly.

3. Fire Performance: ASTM E 108 or UL 790, Class C.

1.06 SUBMITTALS:

A. General: Submit in accordance with Section 01300 - SUBMITTALS.
B. **Product Data:** Submit following Project applicable data.

1. Standard published technical and performance data for all required materials and accessories, including wind tested FM assembly confirming specified Project assembly is in compliance with IBC 2006 requirements.

2. Standard published details applicable to Project assemblies.

3. Nonstandard details required for the Project.

4. Detail adjustments necessary to accommodate specific Project requirements.

5. Specific data required to meet wind and fire performances.

6. Detailed installation instructions. Where standard instructions are provided, provide a separate written document for any deviations from the standard requirements, otherwise, the standard instructions are to be adhered to.

7. Cap sheet color charts.

C. **Shop Drawings:**

1. **General:** Submit Shop Drawings indicating Project specific details which are critical to water tightness of membrane, including but not necessarily limited to, slopes in each assembly, crickets, membrane transitions and terminations at perimeters, drains, mechanical equipment, electrical equipment, and other penetrating elements and related flashing work of each such component.

2. **Layout:** Submit plan drawings for layout of each material layer in system.

D. **Samples:** Submit following.

1. **Modified Bitumen Membrane:** For each type of Modified Bituminous Membrane assembly, submit 48” x 48” representative mockup of the entire assembly from base substrate up to the finished roof membrane. Expose portion of each layer in assembly; at least 4” wide.

2. **Accessories:** Submit samples of accessories.

E. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraphs herein.

F. **Closeout Submittals:** Refer to “Warranty” and “Maintenance” paragraphs herein.
1.07 QUALITY ASSURANCE:

A. General:

1. Comply with all requirements stated under Division 7 - Moisture Protection - Common Work Results, except Third Party review is not required.

2. Each system assembly to include all of the following work under the Modified Bituminous Membrane Manufacturer's umbrella, including the Project Warranty.
   a. Division 7 - Roof & Deck Insulation.
   b. Division 7 - Flashing & Sheet Metal.

B. Modified Bituminous Membrane Manufacturer's System Requirements - Intent:

1. General: Unless otherwise indicated, specified systems are to strictly adhere to Manufacturer's complete and current published literature applicable to each type of assembly specified herein, except as otherwise required to be modified by Manufacturer to accommodate Project specific conditions of performance and installation conditions.

2. Related Materials: Do not use any related materials that are not approved in writing by Modified Bituminous Membrane System Manufacturer specifically for each Project membrane system.

3. Specialty Products: Provide Manufacturer specialty components for terminations and penetrations in their membrane, e.g., flashings, termination bars, reinforced corner assemblies, penetration boots, etc., whether or not specifically specified herein; unless otherwise approved in writing by Manufacturer and acceptable to the University.

4. Mechanical/Electrical Work: Coordinate mechanical and electrical roof penetrations so that each can separately flashed by membrane. Pitch pockets are not allowed. Show coordination as part of Shop Drawing submittal.

1.08 PROJECT & SITE CONDITIONS:

A. Watertight Envelope: At no time during the course of the roofing work is the watertight envelope of the building to be jeopardized.

B. Temporary Roofing: Provide temporary roofing at end of each days work in strict accordance with Modified Bituminous Membrane Manufacturer's requirements.

C. Flashing and Sheet Metal Work: Provide new flashing for all work that impacts watertightness of roofing assembly.
1.09 **WARRANTY:**

A. **Manufacturer’s Warranty:** Submit Manufacturer’s “Manufacturing and Installation Defects Warranty” as follows.

1. **General:** Full system, i.e., all materials from base substrate up and including all flashing and other termination work, no dollar limit warranty, for period of twenty (20) years from date of Substantial Completion; against defects in labor and materials.

2. **Wind Damage:** Each installation to warrantied for Code applicable wind uplift exposure. No restrictions are to be placed on height and exposure conditions of each installation.

B. **Surety:** Surety shall not be held liable beyond two (2) years from the Project Acceptance Date.

1.10 **MAINTENANCE:**

A. **Maintenance Instructions:** Submit for review and include copies in Closeout Manuals.

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**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. **Basis of Design:** Firestone Building Products, Inc. system is described herein and may be incorporated into the Work, subject to compliance with the requirements.

B. **Preapproved Equal Systems:** Preapproved equal systems of the following Manufacturers may be incorporated.

1. Malarkey Roofing Products.
2. Soprema, Inc.

2.02 **ROOFING MEMBRANE MATERIALS:**

A. **Cap Sheet:**

1. **Product:** “SBS FR Torch” cap sheet.
2. **Color:** “UltraWhite”.
3. **Primary Characteristics:**
   a. **Description:** Polyester and glass fiber mat reinforced composite SBS sheet with mineral granular surfacing.
b. **Type:** ASTM D 6163 and 6164, Type I, Grade G.

c. **SRI Index:** 89 minimum.

d. **Net Mass:** 75 lbs / 100 sf minimum.

e. **Thickness:** 130 mils minimum.

B. **Base Sheet:**

1. **Product:** “SBS Poly Torch” base sheet.

2. **Primary Characteristics:**

   a. **Description:** Polyester and glass fiber mat reinforced composite SBS sheet with mineral granular surfacing.

   b. **Type:** ASTM D 6163 and 6164, Type I, Grade S.

   c. **Net Mass:** 54 lbs / 100 sf minimum.

   d. **Thickness:** 85 mils minimum.

C. **Flashings:** Same materials as primary cap and base sheet roofing membrane materials.

2.03 **OTHER PRIMARY ROOF MEMBRANE ASSEMBLY MATERIALS:**

A. **Rigid Roof and Deck Insulation Assemblies:** Modified Bituminous Membrane Manufacturer’s approved insulation assemblies complying with Division 7 – Roof & Deck Insulation Section and including FM 4470 corrosion resistant, mechanical fasteners and stress distribution plates.

B. **Vapor Barrier:** “V-Force Vapor Barrier” product, including “V-Force SB Primer” adhesive.

C. **Flashings and Sheet Metal Work:** Modified Bituminous Membrane Manufacturer’s approved ES-1 compliant flashing assemblies complying with Division 7 – Flashing & Sheet Metal Section.

2.04 **RELATED MATERIALS:**

A. **Membrane Adhesive:** Nonasphaltic, adhesive designed for fully adhered application of Modified Bituminous Membrane Manufacturer’s membrane to each substrate type required.

B. **Other Related Materials:** Following as required by Modified Bituminous Membrane Manufacturer as required to complete each watertight FM compliant Project system as listed in current system publications. Examples include the following.

   1. Wood blocking and nailers, insecticide and fire retardant treated.
2. Elastomeric flashing sheets, reinforced and unreinforced.

3. Membrane cleaners.

4. Primers.

5. Elastomeric sealants for sealing membrane seams, sealing flashing and sheet metal work, other joints in work.

6. Prefabricated components, e.g. penetration boots, prefabricated corner flashing membranes, etc.

7. Nonshrink, non-metallic grout.

8. Walk pads.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. General: Verify existing conditions impacting performance of required Project assemblies. Incorporate or adjust assemblies as required to accommodate field conditions within strict parameters of Modified Bituminous Membrane Manufacturer’s Project requirements to ensure proper performance of each roof assembly.

B. Detrimental Moisture Conditions: Correct detrimental moisture conditions, if present, and as specified in “Quality Assurance” paragraphs herein.

C. Sharp Edges: In addition to other detrimental conditions to membrane installation, ensure that all sharp edges and other puncturing type conditions have been removed.

D. Patching: Patch existing work as required for performances and as necessary to provide a proper substrate for membrane attachment. It is the intent that telegraphing of substrate be minimized to greatest extent possible; so patching work to be done to accomplish this.

3.02 SUBSTRATE CONDITIONS:

A. Start of Application: Do not begin Work where substrate conditions (physical and moisture conditions) and environmental conditions (weather, humidity, and temperature conditions) are not approved by the Technical Representative of the Modified Bituminous Membrane Manufacturer.
3.03 **SYSTEM ASSEMBLY:**

A. **General:** Comply in strict accordance with each membrane system assembly requirements of Modified Bituminous Membrane Manufacturer as fully submitted and successfully reviewed by the University.

3.04 **BLOCKING AND NAILERS:**

A. **Treatment:** Ensure endcuts fully treated.

B. **Height:** Flush with adjacent insulation.

C. **Layout:** Leave 1/8” gaps between adjacent lengths of nailers.

D. **Fastening:** Mechanically fasten to resist 200 plf.

3.05 **RIGID INSULATION ASSEMBLY APPLICATION:**

A. **General:** Install mechanically fastened underlayment, followed by adhesively applied vapor barrier, followed by adhesively applied rigid insulation, followed by adhesively applied overlayment board in accordance with Division 7 – Roof & Deck Insulation Section requirements and to match each Modified Bituminous Membrane Roofing Manufacturer’s FM assembly requirements.

3.06 **MODIFIED BITUMINOUS MEMBRANE APPLICATION:**

A. **Planned Layout:** Install membrane in accordance with layout shown on successfully reviewed the University’s submittals to accomplish following.

1. Result in least number of seams.

2. To ensure that water flow occurs over (top lap to lower lap) and not against seams (lower lap to top lap). Water may flow along seams, but minimize this condition where seams can arranged to have water flow over it.

3. To prevent field seam from intersecting with a drain bowl assembly.

B. **Installation - General:**

1. **Shingled Layout:** Begin installation at low points of roof and in manner shown on Shop Drawing layout sheet. Apply each succeeding ply in shingle fashion with lower edge of upper ply overlapping top edge of lower ply.

2. **Torch Application:** Utilizing Manufacturer approved equipment torch apply membrane materials. Ensure proper and full bond contact with ply surfaces and to each adjacent work. Do not allow wrinkles, air pockets, telegraphing, and other detrimental or
unsightly conditions to occur anywhere at seams or in field of membrane.

3. **Laps:** Maintain Modified Bituminous Membrane Manufacturer’s required side and end laps. Ensure that seaming of laps are properly cleaned and sealed in accordance with Manufacturer’s requirements. Ensure proper and continuous watertight seals.

4. **Reinforcements:** Install Modified Bituminous Membrane Manufacturer’s reinforcements or reinforced sheets at transitions, penetrations, flashings, at discontinuities, and at other areas required by Modified Bituminous Membrane Manufacturer.

5. **Terminations in Membrane:** Where membrane terminates at other materials, e.g. sheet metal flashings, termination bars, banded penetrations, and drains, ensure that work is properly engaged with such adjacent work and fully watertight.

6. **Expansion Joints:** If any, comply strictly with Modified Bituminous Membrane Manufacturer’s requirements.

7. **Walk Pads:** Provide pads to mechanical and electrical equipment and to primary drains. Where not indicated, paths to be in straight line and right angled paths paralleling primary building walls from access points to indicated work. Do not allow pads to occur over seams.

C. **Membrane Inspections:**

1. **General:** Comply with Division 7 – Moisture Protection – Common Work Results Section.

2. **Final Inspection:** Modified Bituminous Membrane Manufacturer’s Technical Representative to conduct final inspection of all work after installation complete and certify roofing installations for warranty. Work not complying with requirements to be repaired and reinspected as required until full warrantable compliance achieved.

3.07 **TERMINATION ASSEMBLIES:**

A. **General:** Install all terminating work to properly complete watertight installation of each complete roofing membrane.

B. **Flashing and Sheet Metal:** Ensure ES-1 flashing assemblies comply strictly with the tested Code requirements.
3.08 CLEANING:

A. **General:** Remove debris from roofing work from the premises and dispose at the end of each working day and upon completion of the work to the satisfaction of the Contracting Officer. Leave roof in good, clean condition.

B. **Bitumen Contamination:** Remove completely from all surfaces.

C. **Drainage Devices:** Clean out any drainage devices, e.g. drains, gutters and downspouts to ensure that there are no blockages that would reduce drainage performance of such devices.

3.09 POST INSTALLATION:

A. **Contractor's Operations:** Verify from Contractor the kinds of operations to be implemented around or over the installed membrane. Advise Contractor of exact methods to be incorporated into his schedule to ensure that the membrane is without damage at time of Substantial Completion. Submit written instructions to Contractor.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Copper flashing and sheet metal work.
   2. Aluminum flashing and sheet metal work.
B. Related Sections:
   1. Division 1 – Sections.
   2. Division 7 – Moisture Protection – Common Work Results.
   3. Division 7 – Roof & Deck Insulation.
   4. Division 7 – Modified Bituminous Membrane Roofing.
   5. Division 7 – Joints Sealers.
   6. Division 8 – Glazed Metal Framing Systems.
   7. Division 15 & 16 Sections.

1.02 DEFINITIONS:
A. Slope Definitions: Following applies only to flashing and sheet metal work relative to any roofing. Code definitions can be different for each primary roofing and other related components.
   1. Low Slope Roofing: Roofs with slopes < 2:12.
   2. High Slope Roofing: Roofs with slopes ≥ 2:12

1.02 SYSTEM DESCRIPTION:
A. Wind Securement Engineering Criteria: Comply with following for all flashing work part of low slope roofing assemblies.
   1. Windload Pressure: Imposed windload pressures based upon IBC 2006 requirements applicable to Project and wind load criteria indicated on Structural Drawings.
2. **Standard:** Complies with ANSI/SPRI ES-1 “Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems”.
   
a. **Low Slope Roofing:** Engineered and tested.

3. **Test Methods:**
   
a. ANSI/SPRI ES-1 Test Method RE-1 resulting in 100 lb/ft securement of membrane.


B. **Non-Engineered Work:** Flashing and sheet metal for other work not impacting low slope roofing work may be standard flashing and sheet metal conforming to cited standards.

1.04 **SUBMITTALS:**

A. **General:** Submit in accordance with Section 01300 - SUBMITTALS.

B. **Product Data:** Submit Manufacturer's data on materials. For sheet metal materials, include data on material and material gages referenced to required standards or indicate that submitted gages are "proposed". For fasteners, submit recommended material types and sizes for each application and for type of sheet metal to be fastened.

C. **Shop Drawings:** Submit. Show materials, gage of sheet metal, layout, joining profiles, and anchorages of fabricated work. Show locations and types of expansion provisions.

D. **Samples:** Submit Project representative samples of each FLSH-# products for review of finish.

E. **Quality Assurance Submittals:** Refer to “Quality Assurance” paragraphs herein.

1.05 **QUALITY ASSURANCE:**

A. **General:** Installer to comply with "Installer" specific requirements in Division 7 - Moisture Protection - Common Work Results Section. Provide all submittals required under that Section.

B. **ANSI/SPRI ES-1 Compliance Submittals:** Comply with one of the following.

1. **Manufacturer's Tested Products:** Submit test data indicating that each Project product complies. Test data to include drawings and fastening requirements specific to each Project installation condition.

2. **NRCA Requirements Meeting IBC Requirements:**
   
a. **Test Data:** Submit NRCA test data that applies to each Project product and installation condition.
b. **Authorized Fabricator**: Submit data that Fabricator has been is authorized and listed as an ITS "Additional Manufacturer" and is able to label Project products with ITS certification labels as sponsored by NRCA and ITS.

C. **Standards – General**: Flashing and sheet metal work to minimally comply with highest quality requirements, e.g. material quality, gage, detailing, fabrication, installation, etc., in following as applicable to each type of work.

   1. Copper Development Association (CDA) applicable publications, including "Sheet Copper Applications".
   2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) "Architectural Sheet Metal Manual".
   3. NRCA's "The NRCA Roofing and Waterproofing Manual".

D. **Coordination**: Coordinate work of other Trades with products requiring flashing and sheet metal work, e.g. roofing, windows, penetration work, etc., to ensure each work is properly installed for watertight performances. Provide in manner that any required Project Warranties are not jeopardized.

E. **Gages**: Specified gages are minimums. Provide heavier gages as required by SMACNA for each type of work required.

1.06 **WARRANTY:**

A. **Manufacturer's Warranty - SPRI ES-1 Assemblies**: Submit following "Manufacturing and Installation Defects" Warranty for not less than same period as required for the roofing warranties, when installed Project products are from an independent Manufacturer approved for Project use by the Division 7 – Modified Bituminous Membrane Manufacturer and regardless of whether it is warrantied under each Roofing Manufacturer's "Manufacturing and Installation Defects" Warranty.

   1. **Material Defects**: Coverage for five (5) year period.
   2. **Performance Defects**: Coverage for blow-off, leaks, or roofing membrane failure due to the flashing assemblies when exposed to wind speeds up to the Manufacturer’s maximum wind speed or the Project Code base wind speed; whichever is the greater wind speed.

B. **Manufacturer's Warranty - Fluoropolymer Coatings**: Submit in accordance with Division 5 – Shop Applied Finishes for Metal Section.
PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS:

A. SM-1: Copper, ASTM B 370, temper H00 or H01, cold rolled; 20 oz. minimum.

B. SM-2: Aluminum, ASTM B 209, 3000 series standard alloy, H-13 to H15 temper; 0.040” gage minimum.

C. Primary Common Characteristics:
   1. Form: From coil stock.
   2. Finish:
      a. Copper: Mill finish.
      b. Aluminum: Match finish of adjacent flashed aluminum work.

2.02 RELATED MATERIALS:

A. Solder: For copper, ASTM B 32, Grade Sn50; 50-50 tin/lead.

B. Epoxy Seam Sealer: For aluminum, 2 part, noncorrosive metal seam sealer for nonmoving, exterior and interior joints, including riveted joints.

C. Fasteners: Comply with Division 5 – Fasteners & Anchors Section.

D. Elastomeric Sealant: Silicone complying with Division 7 - Joint Sealers.

E. Bituminous Coating: SSPC-Paint 12; without deleterious impurities.

F. Roofing Cement: ASTM D 4586, asphaltic.

G. Accessories: Provide accessories as required, including but not necessarily limited, to cleats, reglets, spacers, straps, hangers, brackets, and similar items. Materials to be same as that of sheet metal work for which accessory is scheduled for.

2.03 FABRICATION:

A. General: Shop-fabricate work to greatest extent possible. Comply with details of shop drawings for which review has been successfully completed by the University. Form exposed sheet metal work without excessive oil-canning, buckling and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

B. Gutters and Downspout Assemblies:
   1. Type: “Seamless” installations.
2. **Primary Gutter Runs:** Roll form to indicated profile. Fabricate to provide “seamless” type gutter and downspout assemblies. Hang with “hidden hangers”; unless otherwise indicated.

3. **Gutter Related Components:** Provide inside and outside corners, outlets, elbows, and end caps and other work required to complete each assembly.

4. **Downspouts:**
   a. **General:** Configuration, sizes and fittings as indicated or required to complete each water retaining and leak resistant installation.
   b. **Hangers and Supports:** Comply with cited standards, unless otherwise required by Code or as otherwise indicated, whichever is structurally stronger.

C. **Sill Pans:** Whether indicated or not, provide fully soldered watertight sill pan under all window openings. Fabricate pans with 3/4” minimum upraised sides at jamb and back of each pan with flat bottom of pan extended beyond window on exterior side as required to flash over adjacent finish in manner to assure watertight flashed sill. All joints fully sealed by epoxy or solder as appropriate to each metal type. Exposed portion of any sill pan to match flashed window.

D. **Joints:**
   1. **Non-Moving Joints:**
      a. **Soldered Joints:** For copper, fully solder joints completely through full width and length of seam of not less than 1” width.
      b. **Riveted and Sealed Joints:** For aluminum joints, rivet and fully seal with epoxy seam sealer or University approved butyl joint sealer.
   2. **Moving/Expansion Joints:** Evenly space the expansion joints in a continuous run without exceeding a 30 foot interval between expansion joints. Expansion provision to be not less than 1/8” for each 10 feet of continuous sheet metal work. Seal joints with elastomeric joint sealer where required for weathertight seal.

E. **Drip Edge:**
   1. **Angle:** 45° hemmed edge.
   2. **Size:** 3/4” minimum for copper and 1/2” minimum for all other work.

F. **Cleats:** Provide continuous cleats at all terminations in work requiring cleats.

G. **Penetrations:** Soldered assemblies.
PART 3 - EXECUTION

3.01 INSTALLATION:

A. General: Except as otherwise indicated, comply with referenced standards. Set units true to line and level as indicated and securely anchored in place. Conceal fasteners wherever possible. Anchor units securely in place by appropriate methods without interfering with proper performance of thermal expansion provisions. Install units for weather tight and watertight performance.

B. Downspouts: Exposed downspouts specified in Division 15 Sections.

C. Other Work: Conform to SMACNA standards.

D. Electrolytic Sensitivity:

1. General: Separate flashing and sheet metal work from materials in which the metal is electrolytically sensitive.

2. Method of Separation:

E. Joint Sealing: Comply with same requirements as specified in "Fabrication" paragraphs for soldering or riveting/joint sealing of work. Apply additional joint sealer at other joints in work, if required, to ensure weather tight performance.

F. Penetration Flashing: Bed all flanges of penetration flashing in roofing cement.

3.02 SCHEDULE:

A. General: Comply with following, unless otherwise acceptable to University.

1. SM-1: For all work; except where SM-2 required.

2. SM-2: For flashing of aluminum work, e.g. Division 8 – Glazed Metal Framing Systems Section work.

END OF SECTION
SECTION 07900 – JOINT SEALERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Elastomeric sealants.
      2. Latex sealants.
      3. Miscellaneous sealants.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 7 – Moisture Protection – Common Work Results.
      3. Sections covering work affected by requirements herein.

1.03 SYSTEM DESCRIPTION:
   A. Weather and Air Seal Performance: Provide installations that ensure watertight and airtight continuous seals.
   B. Acoustical Performance: For each type of acoustical performance required, provide number, location and size of sealant beads required by Manufacturer’s tests.

1.04 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: Submit product data for following.
      1. Data for all materials, including recommended primers and fillers.
      2. Data for tested characteristics and performances of each material.
      3. Field test methods required for each sealant product.
C. **Samples:**

1. **Size:** 1/2" beads x 2" long minimum.

2. **Initial Review:** Submit single set of standard bead samples consisting of strips of actual products showing fill range of colors available.

3. **Final Samples:** Submit selected approved color samples from initial review.

D. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraphs herein.

1.05 **QUALITY ASSURANCE – GENERAL:**

A. **Installer Qualifications:** Refer to Division 1 requirements.

B. **Single Source Responsibility:** Refer to Division 1 requirements.

C. **Compliance Division 7 – Moisture Protection – Common Work Results Section:** Following is not required or waived with conditions as stated hereunder.

1. Third Party review is not required.

2. Technical Representative is not required when the Manufacturer submits in writing that the Installer has the requisite experience to provide a watertight installation in accordance with the Contract intent.

1.06 **QUALITY ASSURANCE – ESTABLISHING SUITABILITY OF USE:**

A. **Design Intent – Prior to Manufacture:** For each joint sealing condition and scheduled product for each joint, each Manufacturer to comply with one or both of following before purchase and manufacture of each scheduled Project product for the Work.

1. **Certifications:** Submit written certifications as follows.

   a. **Suitability of Use:** Certify that each Manufacturer’s Project scheduled product is suitable for each use intended, e.g. performances required, joint design, joint size, joint configuration and compatibility with materials each is in contact with.

   b. **Review for Joint Design:** Certify review and acceptance of joint design or provide separate recommendations where joint design is not in conformance with manufacturer's requirements, including for size of joints, configuration, and location.

2. **Testing:** Successfully test each Project scheduled sealant in accordance with following to satisfaction of each Manufacturer and submit written approval of each sealing condition or provide written
recommendations to achieve successful sealing of each tested product in accordance with following.

a. **Replication of Joint Conditions:** Tests to be representative of materials and joint conditions acceptable to each Manufacturer.

b. **Types of Testing Required:**

1) **Adhesion:** ASTM C 794 and ASTM C 719.

2) **Compatibility:** ASTM C 1087.

3) **Staining:** ASTM D 2203, ASTM C 510, or ASTM C 1248.

4) **Immersion Adhesion:** ASTM C 1247.

B. **Design Intent – Pre-Installation Field Testing:**

1. **Test Method:** Just prior to application of joint sealant to each joint, conduct each Manufacturer's field test on each actual constructed joint in accordance with each Manufacturer's field testing requirements submitted and successfully reviewed by University.

2. **Report:** Submit written report confirming successful tests performed and description of final method of assembly to achieve successful installation for each sealant and joint.

1. **PROJECT CONDITIONS:**

A. **Environmental Conditions:** Refer to Division 1 requirements.

B. **Joint Size:** Do not proceed with installation of joint sealers where joint size is not in conformance with Joint Sealer Manufacturer's requirements for application indicated.

1. **WARRANTY:**

A. **Installer Warranty:** Submit "Installation Defects Warranty" for period of two (2) years from date established for Substantial Completion of the Project. In addition to other defects, Warranty to include watertight and airtight joints.

**PART 2 - PRODUCTS**

2. **MANUFACTURERS/PRODUCTS:**

A. **Available Manufacturers/Products:** Subject to compliance with the requirements, manufacturer's offering products which may be incorporated into the Work include, but are not necessarily limited to those indicated herein.
2.02 **ELASTOMERIC JOINT SEALANTS:**

A. **Standard:** ASTM C 920.

B. **Silicone Sealants:**

1. **S-1 – Single Component, Nonsag, for Use NT:**
   a. **Compliance with Standard:** Type S, Grade NS, Class 25.
   b. **Available Manufacturers/Products:** No substitutions of following.
      1) Dow Corning "790".
      2) Momentive “SCS2700 Silpruf”.
      3) Or pre-approved equal.
   c. **Color:** Custom color to be selected by University.

2. **S-2 – One-Part Mildew-Resistant Silicone Sealant:**
   a. **Compliance with Standard:** Type S; Grade NS; Class 25; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure conditions of high humidity and temperature extremes.
   b. **Available Manufacturers/Products:**
      1) Dow Corning Corporation, "Dow Corning 786".
      2) Momentive, "Sanitary SCS1700".
      3) Pecora Corp., “898 Sanitary Mildew Resistant Sealant”.
      4) Tremco “Tremsil 200”.
   c. **Color:** Full range of available standard colors to be selected by the University which is required to include translucent. Manufacturer to be capable of providing custom colors.

C. **Polyurethane Sealants:**

1. **General – Primary Characteristics:**
   a. **Hardness:**
      1) **Test Method:** ASTM D 2240 or ASTM C 661.
      2) **Above Grade Joints:** For any particular S-#, not less than Shore A of specified sealants.
3) **Joints in Pedestrian Trafficked Surfaces:** 30 Shore A minimum.

b. **Custom Colors:** Do not provide sealant from Manufacturer where custom colors are specified, but not available from Manufacturer. One component materials offered in custom colors may be provided, when meeting other specified characteristics, e.g. non-sag or self-leveling.

2. **S-3 – Single Component, Nonsag, for Use NT:**
   a. **Compliance with Standard:** Type S, Grade NS, Class 25.
   b. **Available Manufacturers/Products:**
      1) Bostik, Construction Products Div. of Emhart, "Chem-Calk 900".
      2) Pecora Corp., "Dynatrol I-XL Smooth".
      3) Sika Corporation, "Sikaflex 1a".
      4) Tremco Ltd., "Vulkem 116".
      5) Or pre-approved equal.
   c. **Colors:** Standard colors to be selected by University.

3. **S-4 – Two Component, Nonsag, for Use NT:** Not required.

4. **S-5 – Multi-Part, Self-Leveling, for Use T (Pedestrian Traffic):**
   a. **Compliance with Standard:** Type M, Grade P.
   b. **Available Manufacturers/Products:**
      1) Bostik, Construction Products Div. of Emhart, "Chem-Calk 550".
      2) Pecora Corp. "NR-200 Ureexpan".
      3) Sika Corporation, "Sikaflex – 2c SL".
      4) Tremco Ltd., "THC-900 / 901".
      5) Or pre-approved equal.
   c. **Color:** Custom colors to be selected by University.

2.03 **LATEX SEALANTS:**

A. **Standard:** ASTM C 834.
B. S-6 – Acrylic Emulsion Sealants:
   1. Type: One-part, nonsag, mildew-resistant, paintable, with joint movement capability of ±5%.
   2. Available Manufacturers/Products:
      b. Pecora Corp., “AC-20 Acrylic Latex”.
      c. Tremco Inc., "Tremco Acrylic Latex 834".
   3. Color: Standard colors to be selected by the University.

2.04 MISCELLANEOUS SEALANTS:
A. S-7 – Acoustical Sealants: Not required.
B. S-8 – Multi-Part, Non-Sag, for Use T (Vehicular Traffic): Not required.
C. S-9 – Multi-Part, Non-Sag, for Use NT: Not required.
   1. S-10 – Single Component:
      a. Generic Type: Butyl.
      b. Available Manufacturers/Products:
         1) Pecora Corp. "BA-98".
      c. Color: Gray.
      d. Characteristic: Non-skinning, non-hardening, non-staining and remains permanently flexible for life of sealant under normal service temperature range.

2.05 RELATED MATERIALS:
A. Joint Fillers:
   1. General: Provide sealant backings of material and type which are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by Sealant Manufacturer based on field experience and laboratory testing.
   2. Rod Type Backings: Provide one of following types recommended by each Sealant Manufacturer for each Project specific joint condition.
      a. Plastic Foam Joint Fillers: Closed-cell polyethylene foam; preformed, compressible, resilient, nonwaxing, nonextruding
strips of flexible, nongassing plastic foam; nonabsorbent to water and gas, and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

b. Elastomeric Tubing Joint Fillers: Neoprene, butyl, or EPDM tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient, with low compression set, and of size and shape to provide a secondary seal, to control sealant depth and otherwise contribute to optimum sealant performance.

3. Bond-Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

B. Primers: As recommended by each Joint Sealer Manufacturer for each substrate and project related joint conditions.

C. Cleaners: Nonstaining, chemical cleaners of type which are acceptable to manufacturers of sealants and sealant backing materials, which are not harmful to substrates and adjacent materials, and which do not leave oily residues or otherwise have detrimental effect on sealant adhesion or in-service performance.

D. Masking Tape: Nonstaining, nonabsorbent type compatible with joint sealants and to surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verification of Conditions: Examine joints indicated to receive joint sealers, with Installer present, for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do no proceed with installation of joint sealers until unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Cleaning of Joints:

1. General: Clean out joints immediately before installing joint sealers to comply in strict accordance with joint sealer manufacturers requirements.
2. **Deleterious Substances:** Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust, laitance, form release agents, paints, old joint sealers, oil, grease, waterproofing, water repellants, water, residues from cleaning processes, and surface dirt.

3. **Methods:** Use least destructive method to joint surfaces. Protect exposed surfaces adjacent to joint from damage, even if such surfaces are to be concealed. Appropriate methods may include, brushing and cleaners, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Utilize grinding, blast cleaning, or mechanical abrading when University has been prior advised of the intent of the use of such cleaning methods and has accepted basis for need of such methods, if required. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

B. **Joint Priming:** Prime joint substrates with appropriate Joint Sealer Manufacturer's required primer and in strict accordance with manufacturer's instructions. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

C. **Masking Tape:** Use Masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact. Remove tape immediately after tooling without disturbing joint seal and without damage to adjacent finish.

### 3.03 INSTALLATION OF JOINT SEALERS:

A. **General:** Comply with Joint Sealer Manufacturer's project specific installation instructions applicable to products and applications indicated.

B. **Installation of Sealant Backings:**

1. **General:** Do not leave gaps between ends of joint fillers. Do not stretch, twist, puncture, or tear joint fillers. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material.

2. **Rod Type Backings:** Install at all joints, except where joint configuration require bond breaker tapes.

3. **Bond Breaker Tapes:** Install at shallow joint configurations where rod type backings cannot assure sealant performance, at intersecting and butting surfaces requiring surface application of joint sealer, and other applications where rod type backings are not appropriate and three sided adhesion would otherwise occur.
C. **Installation of Sealants:**

1. **Elastomeric Sealant Installation Standard:** Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability. Installation to comply with following minimum standards.
   a. **Elastomeric Sealants:** ASTM C 1193.
   b. **Latex Sealants:** ASTM C 1193.
   c. **Acoustical Sealants:** ASTM C 919.

D. **Tooling:** Provide concave joint configuration per ASTM C 1193, unless otherwise indicated. Tool sealants to form smooth, uniform beads to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

### 3.04 CLEANING AND PROTECTION:

A. **Staining:** Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur without damage to adjacent finishes and to joint installation.

B. **Protection:** Protect joint sealant installations during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and installations with repaired areas indistinguishable from original work.

### 3.05 SCHEDULE:

A. **S-1 – Silicone:**

1. **Exterior Joints:**
   a. All above grade; except where S-10 required in above grade exterior joints.

B. **S-2 – One Part, Mildew Resistant, Silicone:** All plumbing fixtures, unless other sealants indicated in other Specification Sections.

C. **S-3 – One-Part, Nonsag, Urethane:**

1. **Interior Joints:** Following except where S-4 and S-8 required.
a. At interior side of door, window, louver and other similar frames at “openings” in exterior walls.

D. S-4 – Multi-Part, Nonsag, Urethane: Not required.

E. S-5 – Multi-Part, Self-Leveling Urethane:
   1. Exterior Joints:
      a. Pedestrian trafficked joints.

F. S-6 – Acrylic Emulsion Sealant: Above slab joints of interior work where other S-# sealants are not required.

G. S-7 – Acoustical Sealant: Not required.

H. S-8 – Multi-Part, Non-sag Urethane: Not required.

I. S-9 – One Part, Non-Sag, Polysulfide: Not required.

J. S-10 – One Part, Butyl:
   1. Exterior Joints:
      a. Concealed joints in flashing and sheet metal work.

END OF SECTION
SECTION 08110 – HOLLOW METAL DOORS & FRAMES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   B. Section Includes:
      1. Steel door frames.
      2. Steel flush doors.

   C. Related Sections:
      1. Division 1 Sections.
      2. Division 3 – Cast-In-Place Concrete.
      3. Division 5 – Cold-Formed Steel Framing.
      4. Division 8 – Hardware.
      5. Division 8 – Electronic Access Control.
      6. Division 9 – Metal Support Assemblies.
      7. Sections covering adjacent work impacting door and frame assemblies.

1.03 DEFINITIONS:
   A. Exterior/Interior: Refer to Division 1 requirements.

1.04 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: Submit all applicable Project product data. Include test data for each type of fire rated assembly required.
   C. Shop Drawings: Submit Shop Drawings required for proper fabrication and installation of Project work. Show relationship to each adjacent work. Include requirements for anchorage, hardware location and reinforcement. Schedule frames and reference the same as designations on Contract Documents.
D. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraphs herein.

1.05 **QUALITY ASSURANCE:**

A. **Product Source Responsibility:** Provide doors and frames from single Manufacturer. Refer to Division 1 requirements.

B. **Manufacturer’s Certification:** Submit written certification that hot dipped galvanizing of primary door and frame products comply with requirements.

C. **Coordination:** Coordinate hardware, louver, and glazing requirements with other Installers to ensure proper installation of all door and frame components. Do not fabricate and purchase any fire rated assemblies whose hardware is required for fire performances has not been tested or is Authority approved for use with any specific fire rated door and frame assembly.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. **Available Manufacturers:** Refer to Division 1 requirements.

B. **Standard Doors & Frames:** One of following.
   1. Amweld
   2. Ceco Door, an ASSA ABLOY Group Company.
   3. Curries, an ASSA ABLOY Group Company.
   5. Republic Doors and Frames.
   7. Steelcraft, an Ingersoll Rand Security Technologies Company.
   8. Or pre-approved equal.

2.02 **GENERAL REQUIREMENTS:**

A. **Standards:** Where not otherwise indicated, comply with ANSI 250.8 and SDI (Steel Door Institute) published standards applicable to work specified.

B. **Base Sheet Steel:**
   1. Type: ASTM A 1008, commercial quality, cold rolled steel sheets.
2. Finish: ASTM A 924 and A 653 with hot dipped galvanized finishes complying with following.
   b. Interior: A-60.

C. Shop Paint Finish: Prime painted, ANSI A 250.3 and A 250.10. Ensure primer is compatible with scheduled field applied paint coatings.

2.03 FRAMES:

A. Type: Fully welded units with welds ground smooth, mitered corners, with backbend, double rabbet. Provide non-handed profile unless otherwise indicated. Provide drywall backbend where gypsum board terminates behind frame.

B. Size:
   1. General: 2" face depth, unless otherwise indicated. Frame depth x width x height as indicated or required by partition assembly.
   2. Other: Provide other frame profile and dimensions as required to accommodate scheduled hardware, e.g. electric strikes, etc.

C. Material: ASTM A 1008, commercial quality, cold rolled steel sheets.
   1. Door Openings: As required for performances, but not less than following.
      a. Door Openings, Up to 4'-0": 16 gauge minimum.
      b. Openings 4'-0" to 6'-0": 14 gauge minimum.
   2. Window (Borrowed/Side Lite) Openings: 16 gauge minimum.
   3. Fire Rated Openings: Not required.

2.04 DOORS:

A. Flush Doors: ANSI 250.8 requirements as follows.
   1. Classification:
      a. Exterior: Grade III, Extra Heavy-Duty; Model 2 or 3 as indicated.
      b. Interior: Grade II, Heavy-Duty, Model 2.
   2. Size: 1-3/4" thickness; width x height as indicated.
3. **Construction:**
   
a. **Face Sheets**: ASTM A 1008, commercial quality, cold rolled steel sheets, with gages in accordance with standards (16 gage minimum for exterior doors and 18 gage minimum for interior doors); except provide heavier gage if required to meet door assembly fire rating and wind performances.

b. **Top/Bottom Construction**: Flush end closure treatment.

c. **Internal Construction**:
   1) **Non-Rated - Thermal**: ASTM C 1363 insulating foam core units with R-Value of 4.0 minimum.

   2) **Non-Rated - Acoustically Enhanced**: Not required.

   3) **Non-Rated - Non-Thermal**: Bonded honeycomb or vertical stiffeners with Manufacturer's standard insulation infill.

   4) **Fire Rated**: Not required.

2.05 **ACCESSORIES:**

   A. **Hardware Preparation**: ANSI A 250.6.

   B. **Anchorage Devices**: Hot dipped galvanized, types as required by installation. Where exposed, provide countersunk Phillips flathead types.

   C. **Frame Metal Supports**: 18 gauge minimum, hot dipped galvanized, steel for wall and floor anchors. Provide a minimum of 3 wall anchors per jamb and one adjustable floor anchor per jamb for fastening with two anchorage devices to floor. For pair doors at non-public areas fastened into metal, provide not less than 4 anchors per jamb.

   D. **Dust Guards**: 26 gauge, hot dipped galvanized, at cutouts in frames.

   E. **Lights**: Manufacturer’s standard glazing methods and complying with Division 8 – Glazing Section.

   F. **Louvers**: SDI 111-C, sight-proof V-blade; with 55% minimum free area.

2.06 **FABRICATION - GENERAL:**

   A. **Tolerances**: SDI 117.

   B. **Physical Endurance**: ANSI A 250.4, Level A; 1 million cycle and 23 twist tested.

   C. **Fire Rated Door Assemblies**: Not required.
PART 3 - EXECUTION

3.01 INSTALLATION:

A. Door Assemblies:
   1. **Fire Rated**: SDI 118 and in conformance with Door Manufacturer’s rated assemblies conforming with specified requirements, including for NFPA door/frame fit clearances.
   2. **Non-rated**:
      a. **Frames**: ANSI A 250.8 and A 250.11.
      b. **Doors**: ANSI A 250.8.

B. **Glazed Fire Rated Framed Assemblies**: Complying with Fire Rated Glazing Manufacturer’s requirements; capable of being approved by Local Authorities.

C. **Touch-up**: Touch-up abraded prime coats with same shop primer.

D. **Adjustment**: Adjust assemblies to ensure proper operation.

3.02 SCHEDULE:

A. **Non-Rated - Thermal**: Exterior doors.

B. **Non-Rated - Acoustically Enhanced**: Not required.

C. **Non-Rated - Non-Thermal**: Typical for all doors, except where "Non-Rated – Thermal" doors required.

D. **Fire Rated**: Not required.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Door hardware.
      2. Weather-stripping and seals.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 5 – Metal Fabrications.
      3. Division 8 – Doors & Windows – Common Work Results.
      4. Division 8 – Steel Doors & Frames.
   C. Products Furnished, but Installed Under Other Sections:
      1. Templates: Furnish to each Door and Frame Manufacturer and Installer required to prepare work for Project hardware specified herein.
      2. Cylinders: As Scheduled.

1.03 SUBMITTALS:
   A. General: Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: Submit following.
      1. Hardware Schedule: Submit as follows.
         a. Format: Comply with the Door and Hardware Institute’s publication, “Sequence and Format for the Hardware Schedule” and “Keying Terminology”.
         b. Hardware Sets: Coincide sets with those indicated on Contract Documents, including numbering.
c. **Hardware Set Data:** For each hardware set, indicate applicable scheduled door data, including Contract Document door numbers, number of doors, hand of operation with description of how hand determined, and indicate active door where pair of doors occur.

d. **Hardware Finishes:** Indicate appropriate ANSI/BHMA A156.18 codes.

e. **Fastening Data:** Indicate and clearly highlight following.
   1) Non-phillips head fasteners; exposed to view.
   2) Through door fasteners.

2. **Cut Sheets:** Submit with hardware schedule, manufacturer's technical product data (cut sheets) for each type of hardware required.

3. **Mounting Locations:** Submit mounting location data for each type of hardware required.

4. **Keying Schedule:** Submit with final hardware schedule. Door designations to be same as those on Contract Documents.

C. **Samples:** If requested by University, submit single Project representative samples. Successfully reviewed samples will be returned and may be incorporated into the Work when undamaged.

D. **Quality Assurance Submittals:** Refer to "Quality Assurance" and "Sequencing & Scheduling" paragraphs herein.

E. **Closeout Submittals:** Refer to "Maintenance" and "Warranty" paragraphs herein.

1.04 **QUALITY ASSURANCE:**

A. **Manufacturers:**
   1. **Qualifications:** Each Manufacturer to have ten (10) years continuous and current experience manufacturing hardware of each type required for Project on projects of similar scope and kind.
   2. **Single Source Responsibility:** Obtain "each type" of hardware from a single manufacturer, although several may be indicated as offering products complying with requirements.
   3. **Coordination with Section 08712:** Hardware supplier shall coordinate all hardware items with this Section.

B. **Supplier:**
   1. **Qualifications:** Company specializing in finish hardware of the types required, with warehousing facilities, which has been furnishing hardware in the project's vicinity for a period of not less than 5 years.
2. **AHC Expertise:** Retains an experienced Architectural Hardware Consultant (AHC) or the University’s preapproved equal, who is available, at reasonable times during the course of the work, for consultation about Project's hardware requirements, to University.

C. **Fire-Rated Openings:**

1. **Hardware:** Comply with following. Products that have been tested by other independent and nationally recognized organizations than those required may be incorporated when testing/labeling requirements are acceptable to Authorities having jurisdiction.
   
a. **Standards:** Applicable NFPA 80, NFPA 252, UL10B, and local building code requirements.
   
b. **Listed Hardware:** UL or FM listed for types and sized of doors required and complies with requirements of door and doorframe labels.
   
c. **Exit Devices:** UL or FM label indicating "Fire Exit Hardware".

2. **Manufacturer Certification:** Submit written certification that hardware complies with requirements.

D. **ADAAG Accessibility:** Doors required to be accessible to comply with ADAAG standards including those under 4.13 and 4.26 and any applicable DCAB “Interpretive Opinions”.

E. **Coordination:** Coordinate installation with other Trades impacting hardware installation including, but not limited to, integration with Division 16 - Security System.

F. **Architectural Hardware Consultant Certification:** Submit written certification that hardware installed in conformance with manufacturer's instructions and specifications, and is functioning properly.

G. **Standards:** Cited standards are minimum Contract compliance for each work.

1.05 **DELIVERY, STORAGE & HANDLING:**

A. **Product Handling:**

1. **Hardware Identification:**
   
a. **Packaging:** Retain original Hardware Manufacturer's packaging. Ensure that products are complete, including basic installation instructions. Label each product separately to be readily identifiable with products indicated in hardware schedule.
   
b. **Hardware Sets:** Supplier to identify sets with appropriate hardware set number.
2. **Inventorying:** Inventory hardware jointly between Hardware Supplier and Hardware Installer until each is satisfied that count and assembled sets are correct.

B. **Delivery:** Deliver appropriate hardware at the proper times to Project Site for installation.

C. **Site Storage/Handling:** Contractor to catalogue delivered hardware and store in a secure lockable enclosure, i.e. room, storage cabinet; with hardware stored off ground on shelving. Set up procedure for and limit access to locked hardware. Maintain monitoring and control procedures required for appropriate security and for loss replacement without affecting Project Schedule.

1.06 **SEQUENCING & SCHEDULING:**

A. **Keying Meeting:** Supplier to arrange meeting with University, Contractor, and other involved parties after successful review of hardware schedule and other submittals required with hardware schedule. Establish University’s keying requirements at meeting to ensure all locksets are functionally correct and keying fulfills the project requirements. Submit keying schedule designed by Supplier's Architectural Hardware Consultant based upon established University's requirements as soon as possible after the meeting. Establish exact submittal time at meeting.

1.07 **MAINTENANCE:**

A. **Operation/Maintenance Data:** Submit following as part of Closeout submittals in conformance with Division 1 Sections.

1. Operation and maintenance data, including data on operating hardware, lubrication requirements, inspection procedures related to preventative maintenance, parts lists, and basic installation instructions

2. Keying Schedule and Key Bitting Chart.

3. Record Drawings showing location of each cylinder and each related master key code.


B. **Maintenance Materials:** Special wrenches and tools applicable to each different and special hardware component.

1.08 **WARRANTY:**

A. **Manufacturer Warranty:** Submit "Manufacturing Defects" Warranties as follows.

1. **All Hardware:** One (1) year.

2. **Closers:** Ten (10) years.
3. **Electrical Components**: Two (2) years.

B. **Installer Warranty**: Submit one (1) year "Installation Defects" Warranty.

C. **Warranty Periods**: Specified period starts no sooner than from date certified by University for Substantial Completion of Project.

D. **Surety**: Surety shall not be held liable beyond two (2) years from the Project Acceptance Date.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS**:

   A. **Acceptable Manufacturers**: Design is based upon products listed in "Hardware Schedule" and may be incorporated into the Work. Other comparable products to those indicated in the Hardware Schedule is indicated herein and may also be incorporated in lieu of the specified hardware.

2.02 **HARDWARE, GENERAL**:

   A. **Scheduled Hardware Characteristics**:

      1. **Scheduled Requirements**: Requirements for design, grade, function, finish, size and other distinctive qualities of each type of finish hardware is indicated in the Hardware Schedule at the end of this section.

      2. **Minimum Requirements**: Except as otherwise scheduled or required by Code/Authorities, Part 2 requirements indicate minimum characteristics for which hardware types are required to comply with.

   B. **Standards**: Comply with ANSI/BHMA 156 series standards applicable to type and grade of hardware required.

   C. **Complete Assemblies**: Scheduled hardware indicates primary types and quality of hardware required and is not necessarily descriptive of all components required. Provide standard accessory components as necessary to complete the assembly for a fully functioning unit when installed. Provide finishes matching the primary unit where accessory components are exposed-to-view.

   D. **Base Metals**: Produce hardware units of basic metal and forming methods of products indicated, but not less than following.

      1. **Exterior**: Brass or bronze base metal with plated finish if not a bronze or brass finish; except stainless steel at fire rated work.

      2. **Interior**: Base metal as specified with plated finish; except steel where not the specified base metal and steel or stainless for fire rated work as specified.
2.03 HINGES AND PIVOTS:

A. **Available Products:** Subject to compliance with the requirements, where any one of the products hereunder is specified, the other products are to be considered comparable and may be incorporated into the Project.

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Or pre-approved equal products of each type when required.

B. **Hinge Pins:**

1. **Non-Removable Pins (NRP):** For all reverse hand exterior doors, reverse hand interior main exit corridor doors, regular hand interior doors opening into exit stairwells, and other reverse hand interior doors, scheduled for locksets.

2. **Interior Doors:** Non-rising pins, except as indicated for NRP.

3. **Stainless Steel:** For non-ferrous hinges.

4. **Tip Style:** Flat button.

C. **Hinge Schedule:**

1. **Standard:**
   a. **Hinges:** ANSI/BHMA A156.1.
   b. **Pivots:** ANSI/BHMA A156.4.

2. **Number:** For each leaf, 3 hinges to 90” height; with one additional hinge for each 30” of door height.

3. **Size:** As specified herein.

4. **Type:** Template, ball bearing hinges.

2.04 LOCKS, LATCHES & BOLTS:

A. **Standards:**

1. **Mortise Locksets and Latchsets:** ANSI/BHMA A156.13.

2. **Bored Locks and Latches:** ANSI/BHMA A156.2.
3. **Bolts**: ANSI/BHMA A156.16.

**B. Mortise & Bored Locksets and Latchsets - Available Products**: Subject to compliance with the requirements, where any one of the products hereunder is specified, the other products are to be considered comparable and may be incorporated into the Project.

1. **Corbin-Russwin**: ML2000, CL3300 Series
2. **Sargent**: 8200, 10 Line Series
3. **Schlage**: L9000, ND Series
4. **Yale**: 8800, 5400LN Series
5. Or pre-approved equal.

**C. Levers**:

1. **For**: All doors, unless other operable mechanisms specified, e.g. exit bars.
2. **At Exterior Doors**: Freewheeling when the door is locked to 70º maximum.

**D. Strikes**:

1. **Typical**: Provide standard wrought box strike for latch or bolt, or both, with extended lip to protect each door frame.
2. **Footbolts**: Provide with dustproof strike.

**E. Bolts and Latches**:

1. **Latches**: 3/4" minimum throw.
2. **Bolts**: 1" minimum throw.
3. **Flushbolts**: 1/2" diameter rods of brass, bronze or stainless base metal. 12" long rods for doors up to 7'-0" in height and 42 " length thereafter for doors up to 9'-0" in height.
4. **Thumbturns**: Comply with current ADAAG requirements.

2.05 **LOCK CYLINDERS AND KEYING**:

**A. Cylinders**:

1. **Type**: As specified.
2. **Construction System**: Furnish construction cores with locksets to Contractor.
3. **University's Permanent System:** Deliver permanent cores directly to University's authorized Representative at time requested by University by method required to ensure secure delivery to University.

**B. Keying:**

1. **Construction Keys:** As required by Contractor and approved by University.

2. **Grand Master Key System:**
   a. **System:** As determined with University.
   b. **Keys per Lock:** 4 minimum; with 2 with bitting number and 2 without bitting number.
   c. **Keys per Masterkey Level:** 6 minimum.

2.06 **CLOSERS:**

A. **Standards:** ANSI/BHMA A156.4 and current ADAAG requirements.

B. **Available Products:** Subject to compliance with the requirements, where any one of the products hereunder is specified, the other products are to be considered comparable and may be incorporated into the Project.

1. **Corbin-Russwin:** DC 6000 Series.
2. **LCN:** 4041 Series.
3. **Norton:** 7500 Series.
4. **Sargent:** 351 Series.
5. Or pre-approved equal.

C. **Primary Characteristics:**

1. **Door Operation:**
   a. Adjustable to allow exterior doors to operate at 8.5 pounds maximum force and interior doors at 5 pounds maximum of force.
   b. Adjustable to allow fire doors to operate at 15 pounds of force maximum.
   c. Brass adjustment valves for control of closing speed, latching speed and backcheck.

2. **Mounting and Arm Type:** Regular or parallel arm and mounting hardware as required to mount closer in manner described in "Execution" paragraphs herein.
3. **Covers:** Provide on all closers. Where plastic types specified with color to be selected by the University where not indicated.

2.07 **OTHER HARDWARE:**

A. **Auto Door Bottoms:** As scheduled; with end closures, continuous for width of door.

B. **Smoke Seals:** At 1/3 hour rated door assemblies and as scheduled; fire tested, continuous at jambs and head.

C. **Weather Seals:** As scheduled, continuous at jambs and head.

D. **Astragals:** 18-gage minimum, but not less than required for tested assembly provided for.

E. **Thresholds:**

   1. **Standard:** ANSI/BHMA A156.21 and current ADAAG requirements.

   2. **Type:** As scheduled, or where not scheduled provide a manufacturer's standard flat threshold, with standard cast or extruded non-slip profile.

   3. **Base Material:** Aluminum as listed.

   4. **Size:**

      a. **Width:** Door width.

      b. **Depth:** As indicated; where not indicated flat portion to be not less than frame depth.

      c. **Height:** As indicated; except do not exceed 1/2" height where handicap access is required, and where not indicated, 1/2" height.

   5. **End Returns:** Mitered end returns where ends would otherwise be exposed; of material/finish to match primary threshold unit.

   6. **Method of Fastening:** Provide manufacturer's special concealed fastener system for installation for single units. Through-bolting may be provided for matched pairs.

2.08 **RELATED MATERIALS:**

A. **Anchorage Devices:** Furnish with each hardware type required.

   1. **Types:** Wood and machine screws and other appropriate anchorage devices applicable to type of substrate fastened to.

   2. **Not Allowed:**

      a. Self-tapping sheet metal screws.
b. Through-bolts with head or nut exposed on opposite face of work hardware is fastened to.

3. **Head Style:** Phillips flat-head devices.

4. **Metal Alloy:** Same as fastened hardware. Ferrous products to be hot dipped galvanized.

5. **Finish:** Match finish of primary fastened hardware, even when such hardware is scheduled for field painted coatings.

B. **Sealant:** For thresholds, single component silicone complying with Division 7 - Joint Sealers.

**PART 3 - EXECUTION**

3.01 **INSTALLATION:**

A. **Mounting Heights:**

1. **General:** Mount hardware units at heights required to comply with ADAAG and then as indicated in "Recommended Locations for 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.

2. **Deadlocks:** 5" to centerline above latchset.

3. **Closers:** Locate on side of doors as follows.
   a. **Exterior Doors:** On interior face.
   b. **Interior Doors:** Following priority with first being highest.
      1) On non-public facing side.
      2) Not within corridors.
      3) Exit stair shafts; on stair side.
      4) On inner most room or space.

B. **Installation, General:** Install each hardware item in compliance with the manufacturer's instructions and recommendations. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
C. **At Painted Surfaces:** Where hardware is scheduled to be installed onto or into surfaces that are later to be painted or finished in another way, install each hardware completely and remove prior to finishing operations, except as otherwise coordinated with Painting Installer for hardware products primed for painting. Reinstall removed hardware upon completion of finishing operations.

D. **Anchorage Devices:** Countersink devices flush with fastened surface. Space in accordance with industry standards.

E. **Thresholds:** Set in full bed of sealant at exterior locations to ensure waterproof integrity.

3.02 **ADJUSTMENT AND CLEANING:**

A. **Adjustment:** Adjust and check each operating item of hardware to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly.

B. **Cleaning:** Clean adjacent surfaces soiled by hardware installation.

C. **Final Adjustment:** Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to work during the week prior to acceptance, and make final check and adjustment of all hardware items in such space or area. Clean and lubricate operating items as necessary to restore proper function and finish of hardware and doors.

D. **General Adjustment:** Adjust and lubricate operational components for smooth operation. Check closure and fit of acoustical and weather performing hardware.

E. **Construction Cores:** Coordinate removal of construction cores with University’s installation of his permanent system. Return construction cores to Hardware Distributor. Pay for any missing cores.

3.03 **DEMONSTRATION:**

A. **University's Personnel:** Instruct in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.04 **HARDWARE SCHEDULE:**

**MANUFACTURER ACRONYMS**

BEA: B.E.A., Inc.
MCK: Mckinney Products Company
PEM: Pemko
RIX: Rixson Door Controls
SAR: Sargent Manufacturing Company
TRI: Trimco
## TECHNICAL SPECIFICATIONS

**Hardware**

### HW GROUP - 001

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Model/Spec</th>
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<tbody>
<tr>
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<td>ElecT. ConT. Hinge</td>
<td>CFM83HD1 X CC12-SER PEM</td>
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<tr>
<td>2.0</td>
<td>ElecT. Panic Device</td>
<td>H1-11-72-73-AD8674 ETL US32D SAR</td>
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<tr>
<td>2.0</td>
<td>O.H. Concealed Closer</td>
<td>0700 US28 RIX</td>
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<tr>
<td>2.0</td>
<td>Door Status Switch</td>
<td>*3287 SAR</td>
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<tr>
<td>2.0</td>
<td>Xc Core Key System</td>
<td>11-7300B US15 SAR</td>
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<tr>
<td>2.0</td>
<td>Floor Stop</td>
<td>1215CKU 626 TRI</td>
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<tr>
<td>1.0</td>
<td>Threshold</td>
<td>171A 72&quot; PEM</td>
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### NOTES:

1. * PRODUCTS SUPPLIED AND INSTALLED UNDER SECTION 08712.

### HW GROUP – 002

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<td>1.0</td>
<td>Door Closer</td>
<td>351 PH9 EN SAR</td>
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<td>1.0</td>
<td>Semi Auto Flush Bolt</td>
<td>3820 X 3810 630 TRI</td>
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<td>1.0</td>
<td>D.P. Strike</td>
<td>3910 630 TRI</td>
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<td>Armor Plate</td>
<td>KA050-2 34&quot; X 35&quot; 630 TRI</td>
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<td>Armor Plate</td>
<td>KA050-2 34&quot; X 17&quot; 630 TRI</td>
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<td>Surface Vr Exit Dev</td>
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<td>351 PH9 EN SAR</td>
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<td>1270WX 626/630 TRI</td>
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<td>*3287 SAR</td>
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<td>2.0</td>
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<td>222AV PEM</td>
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**Project No. SW-12-6238**

**08700-12**
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**NOTES:**

1. *PRODUCTS SUPPLIED AND INSTALLED UNDER SECTION 08712.

**HW GROUP - 005**

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<td>Door Status Switch</td>
<td>*3287</td>
<td>SAR</td>
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<td>Door Closer</td>
<td>351 PH9 EN</td>
<td>SAR</td>
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<td>2.0</td>
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**NOTES:**

1. *PRODUCTS SUPPLIED AND INSTALLED UNDER SECTION 08712.

**HW GROUP - 006**

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<td>1.0</td>
<td>Wall Bumper(convex)</td>
<td>1270WX 626/630</td>
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**NOTES:**

1. *PRODUCTS SUPPLIED AND INSTALLED UNDER SECTION 08712.

**HW GROUP - 007**

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### HW GROUP - 008

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<td>1.0 Ea</td>
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<td>1.0 Ea</td>
<td>Door Closer 351 H EN SAR</td>
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<tr>
<td>1.0 Ea</td>
<td>Entry Lock *11-72-73-28-10G24 LL US26D WBXSAR</td>
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<td>1.0 Ea</td>
<td>Xc Core Key System 11-7300B US15 SAR</td>
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<tr>
<td>1.0 Ea</td>
<td>Door Bottom 315CN 36&quot; PEM</td>
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<tr>
<td>1.0 Ea</td>
<td>Door Seal S88D17 PEM</td>
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<tr>
<td>1.0 Ea</td>
<td>Wall Stop (concave) 1270WV 626/630 TRI</td>
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**NOTES:**

1. * LEAD LINED INSIDE ROSE & LATCH.

### HW GROUP - 009

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<td>1.0 Ea</td>
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<td>1.0 Ea</td>
<td>Mortise Deadlock *11-72-73-4875 US26D SAR</td>
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<td>Push Plate 1001-3 630 TRI</td>
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<td>1.0 Ea</td>
<td>Door Bottom 315CN 36&quot; PEM</td>
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<td>1.0 Ea</td>
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**NOTES:**

1. * LEAD LINED INSIDE ROSE & LATCH.

### HW GROUP - 010

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<td>1.0 Ea</td>
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**TECHNICAL SPECIFICATIONS**

Hardware

Project No. SW-12-6238

08700-14
HW GROUP - 011

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END OF SCHEDULE
SECTION 08712 – ELECTRONIC ACCESS CONTROL

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A. As specified in SECTION 01001 – GENERAL REQUIREMENTS.

1.02 SUMMARY

A. The work included in this section of the specifications shall furnish, deliver, and install new EAC components where indicated to provide a campus-wide electronic access control system as specified.

B. The new EAC components shall be compatible with the existing EAC system where scheduled to remain.

C. An Electronic Access Control Schedule is provided in the plans for “information only” of existing doors scheduled to receive EAC campus wide. The Contractor shall be responsible for field verification of all existing doors, locksets and cylinder types as required to provide a new electronic access control system before submitting a bid. No increase in price will be permitted for Contractor’s not having visited the site and confirmed conditions and quantities.

D. The work included in this section will also include complete set up including entering all doors, buildings and key symbols for the key management software specified herein.

E. Examine the drawings, specifications, and jobsite verification to check all components so they will be suitable and of perfect fit, installed where and when required.

F. The following materials and services, as generally described, are encompassed by this system specification and shall include but not be limited to:

1. Door Hardware
2. EAC Hardware
3. EAC Software
4. EAC Credentials
5. System Installation
6. System Setup
7. System Support
8. End-User Training

G. Certification: Installation, setup and servicing of all components shall be performed by a contractor whom is trained, certified and authorized by the system manufacturer(s) to perform such duties.
H. Related work described elsewhere:

1. SECTION 08715 – HIGH SECURITY KEY AND LOCK SYSTEM
2. SECTION 16050 – ELECTRICAL GENERAL REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
3. SECTION 16402–16140 – WIRING SYSTEMS

1.03 REFERENCES AND ABBREVIATIONS

A. The standards, technologies, methods, algorithms, systems, entities or other items defined as follows shall hereinafter be referenced by the respective and associated abbreviation or acronym; most current edition.

1. ISO – International Organization for Standardization
2. IEC – International Electrotechnical Commission
   a. 60086 – Portable Primary Batteries
3. ISO/IEC JTC 1 – ISO/IEC Joint Technical Committee 1
   a. 7810 – Physical Characteristics for Identification Cards
   b. 14443 – Contactless Integrated Circuit Cards
4. IEEE – Institute of Electrical and Electronics Engineers
   a. 802.15.4 – Low-Rate Wireless Personal Area Networks
5. ANSI – American National Standards Institute
   a. A115.1 – Mortise Lock Preparation
   b. A115.2 – Cylindrical Lock Preparation
   c. A156.2 – Bored Locks and Latches
   d. A156.3 – Exit Devices
   e. A156.13 – Mortise Locks and Latches
6. UL – Underwriters Laboratories, Inc.
   a. UL 10B – Fire Tests of Door Assemblies
   b. UL10C – Positive Pressure Fire Tests of Door Assemblies
   c. UL 1034 – Burglary-Resistant Electric Locking Mechanisms
7. FCC – Federal Communications Commission
8. EAC – Electronic Access Control
9. ESS – Electronic Security System
10. LAN – Local Area Network
1.04 SUBMITTALS

A. Submit in accordance with SECTION 01300 – SUBMITTALS.

B. Complete Submittals: Shall include scheduling of all doors sorted by buildings, electronic access control type and any other information required for each door. Furnish manufacturers product data including descriptive and technical data for verification purposes.

C. Keying Schedule: Keying of locks shall be as indicated on a Key Schedule submitted by the supplier with information obtained from the Windward Community College (WCC) Facilities Management Office. Door designations shall be the same as those used on drawings.

D. Online Locks: Furnish product and technical data.
E. **Electronic Access Control Software**: Submittals shall include complete details, specifications including required processor, MB hard disk space, operating system, etc.

F. **System Workstation**: Submittals shall include processors, monitor, software and all components specified.

G. **Power Supply**: Furnish complete details and specifications.

H. **UPS**: Furnish product and technical data.

I. **Warranty**: Submit warrant as stipulated hereinafter.

1.05 **DELIVERY, STORAGE AND HANDLING**

Contractor shall deliver and store products in manufacture’s unopened packaging in an enclosed area in accordance with manufacturer’s recommendations.

1.06 **PROJECT CONDITIONS**

A. Contractor shall verify that environmental conditions, including temperature and humidity, are within the manufacturers stated product limits prior to and during installation.

B. Contractor shall furnish door hardware, EAC hardware of proper design and use on existing doors and frames of the proper thickness, profile, swing, security and similar requirements indicated as necessary for the proper installation and function, regardless of omissions or conflicts in the information stated within the contract document.

C. Should items of hardware not definitely specified be required for the completion of work, the Contractor shall furnish such items of type and quality comparable to adjacent hardware and appropriate for services required.

D. Where items of hardware are not definitely or correctly specified, are required for completion of the work, Contractor shall provide a written statement of such omission, error, or other discrepancy to University, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the design and function intent.

1.07 **REPRESENTATION AND SERVICE**

Provide services of a competent EAC specialist whom is familiar with the installation, operation, configuration, programming, and service of the EAC system specified. Specialist shall meet with the University to develop the Electronic Access Control System and coordinate installation.
1.08 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Engage qualified manufacturers with a minimum five (5) years of documented experience in providing access control and security systems equipment and software similar to that indicated for this Project and that have a proven record of successful in-service performance.

1. Software and access control systems components shall be previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.

B. Installer Qualifications: Systems Integrators, verifiably factor trained and certified by the primary product manufacturers, with a minimum three (3) years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not necessarily limited, to the following:

1. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.

2. Professional Staffing: Firms to have a dedicated access control system integration department with full time, experienced professionals on staff experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.

3. Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system.

4. Service Center: Firms shall have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project Site with 24-hour/7-days a week maximum response time.

C. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:

1. Comply with NFPA 70 “National Electrical Code”, including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


5. The installation access control system shall conform to all local jurisdiction requirements.

1.09 WARRANTY

The contractor shall submit warranty document(s) for EAC system components. The warranty period shall be two (2) year from the date of acceptance. Defective materials shall be replaced or repaired by the Contractor at no cost to the University.

1.10 COORDINATION

A. Coordinate quantity and arrangement of assemblies with ceiling space configuration and with components occupying ceiling space, including structural members, pipes, air-distribution components, raceways, cable rays, recessed lighting fixtures, and other items.

B. Access Control System Electrical Coordination: Coordinate the layout and installation of scheduled electrified door hardware, and related access control equipment, with required connections to source power junction boxes, power supplies, detection and monitoring hardware and fire alarm system.

C. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing electrified door hardware and access control system components. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing access control system hardware to comply with indicated requirements.

D. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.11 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for the University’s continued adjustment, maintenance, and removal and replacement of the installed access control system hardware and components.
B. Maintenance Service: Beginning at Project Acceptance, and running concurrent with the specified warranty period, provide continuous twelve (12) months full maintenance by skilled employees of the Systems Integrator. Include repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacturer and installation of original products.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. General: This technical specification is performance-based according to the requirements of the University. Manufacturers and part numbers referenced within the attached hardware schedule are included to demonstrate design intent and illustrate hardware which satisfies the general requirements described herein.

B. Exclusions: Certain details regarding door hardware have been excluded from this technical specification and the attached hardware schedule. Contractor is responsible for verifying all conditions and ensuring the correct application, which shall be submitted and approved by the University, of items not otherwise specified. Details excluded are, but not limited to:

1. Finish (match existing)
2. Door Width
3. Door Height
4. Door Handing
5. Trim Style (match existing)
6. Lever Style (match existing)
7. Cylinders (for mechanical hard-key override; see SECTION 08715 – HIGH SECURITY KEY AND LOCK SYSTEM).

C. Manufacturers:

1. This technical specification is not proprietary product designation and manufacturers are listed for the purpose of establishing requirements.

2. Approved Electronic Access Control System Manufacturers:
   a. Schlage Electronics AD Series
   b. Sargent Manufacturing
   c. Johnson Control P2000
3. The access control hardware contained in this specification represents a complete engineered system. If alternate products are submitted, it is the responsibility of the Supplier/Dealer/Integrator to provide an acceptable complete and working system layout. Complete systems to include at a minimum required power supplies, power transfers, and integrated locking hardware and accessories.

4. Requests for substitution shall be submitted in good faith and as a declaration that the proposed alternative system meets or exceeds the performance and technical requirements described within this system specification.

5. Requests for substitution shall be submitted with appropriate documentation that describes technical, function and performance information of the proposed alternative system.

6. Requests for substitution shall be submitted in accordance with SECTION 01001 – GENERAL REQUIREMENTS.

2.02 DESIGN AND PERFORMANCE

A. Compliance:

1. The EAC system architecture shall consist of the system components listed herein to satisfy the specific design intent of the EAC system.

2. Each EAC system component shall adhere to the prescribed purpose, performance, design intent and function of said component.

3. Each EAC system component shall adhere to the prescribed technical and operational requirements of said component.

B. Principal of Operation:

1. The EAC system shall utilize a fully integrated combination of wired access control hardware and wired online electronic locks.

   a. The purpose of wired access control hardware and wired online electronic locks is to provide maximum reliability for access control conditions deemed critical, including but not limited to perimeter points of ingress and egress, which shall be seamlessly integrated and controlled by the unified system.

2. All system components shall be seamlessly integrated, controlled and managed by a single EAC system and interface, no exceptions. Said components shall include, but not be limited to, the following:

   a. Wall Reader with keypad
   b. System Controller
   c. Online Electronic Lock
d. Credential
e. Wired Door Hardware
f. Wired Access Control Hardware

C. System Components:

1. Wall Reader with Keypad
   a. Shall be used at specified wired door(s) in which the door(s) are mechanically secured by electric door hardware.
   b. Each shall be connected to designated input on the System Controller.
   c. Shall securely read information from the Credential and communicate said information with the System Controller or Door Interface to which it is connected.
   d. Shall be compatible for dual credential with one or more of the following CSC and PICC technologies operating at 13.56MHz and 125KHz:
      1) MIFARE
      2) MIFARE DESFire EV1
      3) HID iCLASS
      4) HID Proximity

2. System Controller: Shall be used at the central network location(s) at each respective building to interface with a designated door’s Wall Reader, electrified door hardware, door position switch and the EAC system server.
   a. Communicate with the EAC system server securely via TCP/IP protocol via a single unique dedicated IP address.
   b. Communicate with expansion door interface(s) via RS-485 for expanded capacity of up to a minimum of 16 doors on a single unique dedicated IP address, when applicable.
   c. Locally store and maintain EAC system information to allow continued nominal operation in the event that communication with the EAC system server is interrupted or otherwise unavailable.
   d. Shall require 1 unique IP address on the designated EAC system network.
3. Power Supply: Power shall be continuously monitored and, if interrupted, automatic switching from primary to emergency backup sources shall be accomplished without interruption or degradation of critical systems function. Alarms shall be not generated as a result of power switching. Non-alarm indication of power switching and current on-line source shall be provided at the system server and system client workstations. Upon restoration of primary power, system shall automatically switch back to the primary source. Failure of an on-line battery shall be detected and reported as a fault condition.

   a. Primary Power: Furnish 120VAC, transformed through a two-winding isolation transformer and rectified to 24VDC or 12VDC output, as specified herein, for system operation. Obtain primary power at the location indicated.

   b. Backup Power: Provide backup DC power at the specified output voltage in each element or subsystem, appropriate to supply power to all attached components for a duration no less than 2 hours of mean nominal system operation. Batteries shall be nickel-metal hydride, lithium-ion or sealed acid gel-cell type. Batteries shall be chemically sealed and operate the entirety of the service life with no requirement of periodic maintenance or conditioning, including but not limited to the routine addition of electrolytes and/or water to the battery cell. The rated service life shall be a minimum of 3 years.

   c. Outputs: Provide a minimum of 16 individually overcurrent protected, by fuse or other circuit interruption device, DC outputs at the specified output voltage. Provide relay control for each access control interface, as appropriate for the respective condition.

4. Online Lock: Power shall be supplied by conductors which are hard-wired to the electronic Online Lock, including but not limited to power provided by a PoE network connection or a special lock interface panel.

   a. Emissions radiated by the lockset shall be standards-compliant:

      1) FCC, Part 15, Class A

   b. Lockset shall contain a PCD for the purpose of interfacing with a PICC credential.

   c. Shall be compatible with the following standard CSC and PICC technologies:

      1) MIFARE
      2) MIRFARE DESFire EV1
      3) HID iCLASS
      4) HID Proximity

   d. Shall be compliant with ISO/IEC JTC-1 standard:
1) ISO/IEC 14443A-1
2) ISO/IEC 14443A-2
3) ISO/IEC 14443A-3

e. Shall conform to ANSI A156.2, Series 4000, Grade 1.

f. Shall conform to UL standard:

1) UL 10B
2) UL 10C
3) UL 1034

g. Shall retain a rolling history of the most recent 1,000 system events.

5. Credential - Credential shall have embedded CSC and PICC technology.

a. CSC/PICC technology shall be conformant with:

1) MIFARE
2) MIRFARE DESFire EV1
3) HID Proximity

b. CSC/PICC technology shall be compliant with ISO/IEC JTC-1 standards:

1) ISO/IEC 14443-1
2) ISO/IEC 14443-2
3) ISO/IEC 14443-3
4) ISO/IEC 14443-4

c. CSC/PICC technology shall have 4KB total integrated memory.

d. CSC/PICC technology shall operate on the RF frequency 13.56MHz and 125KHz.

e. CSC/PICC technology shall utilize the encryption standard AES-128.

f. Credential shall be furnished blank and white in color.

g. Credential shall be printable.

6. System Software (Existing)

a. System software shall provide an interface to seamlessly manage all devices connected into the integrated system, including but not limited to:

1) All devices and hardware related to wired doors.
b. System software shall have the capacity to manage up to 10,000 number doors and/or other points of control.

c. System software shall manage up to 50,000 credentials.

d. System software shall contain the fundamental functionality and operation required for an access control system, including but not limited to the processing and handling of access control inputs and outputs such as door position and request to exit signals.

e. System software shall contain all access control features reasonably expected by a Physical Security Professional to be utilized in a campus application, including but not limited to forced entry and extended door open events.

f. All components of the system shall be fully integrated so that any forms of redundant data input or similar tasks are eliminated in their entirety. This requirement shall apply to all aspects of the system installation, setup and operation.

g. All EAC system data shall centrally reside within 1 database on the existing system server.

  1) Use of more than 1 database to manage, control or integrate all system components shall not be permissible.

h. Backup database(s) which mirror or archive the sole primary database shall be permissible if said database(s) are used for recovery operations and are otherwise not manipulated during nominal operation of the EAC system.

i. Software functioning as an EAC system client workstation shall reside on 3 client computers, to be furnished by the Contractor as specified.

7. System Workstation: Furnish and configure 3 EAC system workstation computers as specified herein.

   a. Shall utilize an operating system compatible with the EAC system.

   b. Shall be of commercial-grade hardware which has been deemed suitable to the specific application and approved by the EAC system manufacturer. Documentation of such approval shall be furnished by the Contractor to the University.

   c. Shall be connected to and utilize a dedicated desktop UPS.
d. Shall utilize a processor, memory and other components not further specified that meet or exceed the requirements of the EAC system manufacturer and additionally meet or exceed the following:

- Processor: (1) 2 Core 2.00 GHz
- RAM: (2) 2 GB DDR3 1333MHz
- RAID: (1) 140 GB 10000 RPM
- NIC: (1) 1Gb
- Power Supply: (1) 200W

e. Shall be of a standard desk top tower form factor.

f. Shall include an 21-inch or greater LCD monitor with a resolution no less than 1920 x 1080, USB keyboard and USB pointing device.

g. Shall require 1 unique IP address on the designated EAC system LAN.

h. Shall be approved by the University.

8. Uninterruptable Power Supply: For each System Workstation, furnish 1 dedicated UPS. Power shall be continuously monitored and, if interrupted, automatic switching from primary to emergency backup sources shall be accomplished without interruption or degradation of critical systems function.

a. Primary Power: Furnish 120VAC power which is continuously monitored for general power quality, using factors including but not limited to alternating frequency, input voltage, and sine wave differential between peak voltage and peak amperage. Provide 120VAC power as the output.

b. Backup Power: Provide 120VAC backup power to sustain mean nominal operation of the attached System Workstation for a duration no less than 2 hours. Backup power shall be derived from the inversion of DC power provided by integral batteries. Integral batteries shall be nickel-metal hydride, lithium-ion or sealed acid gel-cell type. Batteries shall be chemically sealed and operate the entirety of the service life with no requirement of periodic maintenance or conditioning, including but not limited to the routine addition of electrolytes and/or water to the battery cell. The rated service life shall be a minimum of 3 years.

c. UPS for system workstation shall be desk top type, minimum 865-watt/1500-volt ampere rating. “APC Back-UPS Pro model number BR1500G” or pre-approved equal.
9. Other: Any special equipment required for the full functionality of all systems components but not otherwise specified herein shall be furnished by the Contractor. It is the responsibility of the Contractor to determine all components required for the specified operation of the access control system, including but not limited to special configuration or programming devices.

PART 3 – EXECUTION

3.01 GENERAL

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance of the installed access control system.

B. Examine roughing in for electrical source power to verify actual locations of wiring connections before electrified and integrated access control door hardware installation.

C. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

D. Examine door frame to ensure wiring can be installed according to plans, specifications and manufacturer’s recommendations.

E. Notify University of any discrepancies or conflicts between the specifications, drawings and scheduled access controlled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.02 PREPARATION

Doors and frames at scheduled access controlled openings to be properly prepared to receive specified electrified and access control hardware and connections without additional in-field modifications.

3.03 INSTALLATION

A. Install each item of electronic access control equipment to comply with manufacturer’s written instructions and according to specifications.

B. Mounting Heights: Mount electronic door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:


3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 “Accessibility Guidelines for Buildings and Facilities.”

C. **Power Supplies:** Verify locations.

1. **Configuration:** Provide the least number of power supplies required to adequately serve doors with access control hardware and equipment.

D. All consoles, terminals, and controllers shall be factory wired before shipment to the job site.

E. Cabinet doors shall open a minimum of 170 degrees to avoid booking personnel movement. Each door shall be equipped with a cylinder lock, a tamper switch and a piano-type hinge with welded tamperproof pins.

F. Provisions shall be made for field wiring to enter the cabinet via standard knockouts at the top, bottom and sides of controller cabinets.

G. Each wire shall be identified at both ends with the wire designation corresponding to the wire numbers shown on the wiring diagrams.

H. All exposed wiring within the cabinets, consoles, and terminals shall be formed neatly with wires grouped in bundles using non-metallic, flame-resistant wiring cleats or wire ties.

I. All ferrous metal work shall be painted, in accordance with the manufacturer’s standards.

J. Final connection of the system control switches (integrated card keying locking hardware, remote readers, keypads, display terminals, biometrics), and monitoring, and signaling equipment to the related Controller devices at each opening to properly operate the electrified access control hardware according to system operational narratives.

K. **System Application Software:** Install, and test application(s) software and databases for the complete and proper operation of systems involved. Prior to assigning software license(s), confirm to the University.

3.04 **FIELD QUALITY CONTROL**

A. **Field Inspections:** Engage an authorized systems manufacturer representative to perform a final inspection of the installed electronic integrated door hardware and access control system and state in report if installed work complies with or deviates from requirements, including if each component representing the opening assembly is properly installed, adjusted, operating and performing to system operational narratives.
B. Testing and Commissioning:

1. The Contractor shall be responsible for testing and commissioning the installation in accordance with all applicable documents in the Contract set prior to final acceptance of the access control system installation. The following testing and documentation shall be performed and provided to the University.

   a. Testing shall be comprehensive and sufficient to demonstrate compliance with each requirement.

   b. A proposed test plan shall be submitted to the Architect and the University’s representative for acceptance before commencement of final test.

   c. Final tests shall be conducted in the presence of the Architect and the University’s representative.

2. Adjust and check each operating item of integrated access control door hardware, and each door opening to ensure proper secured operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

3. Inspection: Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

4. Pre-Testing: Program and adjust the system and pretest all components, writing, and functions to verify they conform to specified requirements. Provide testing reports indicating devices tested, pass/fail status, and actions taken to resolve problem(s) on failed tests.

5. Acceptance Test Schedule: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

6. Provide “as designed” drawings showing each device and wiring connection and electronic enclosure legends indicating cabling in and out.

7. Provide a complete set of operating instructions for access control hardware devices and a complete software user manual. The documentation includes module reference guides for each electronic enclosure.

3.05 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by access control system installation.

B. Clean operating items as necessary to restore proper finish and provide final protection and maintain conditions that ensure access control door hardware is without damage or deterioration at time of owner occupancy.
3.06 TRAINING AND INSTRUCTION

A. Central server operator training shall include at a minimum forty-eight (48) hours on-site by a factory trained professional instructor. Training conducted by unqualified personnel is unacceptable. Include a minimum of eight (8) hours of client software application (client workstation) at each of the remote facilities for local administrative staff.

B. Training materials shall consist of the following:

1. Formal course outline and agenda.
2. Operator training student guide for each student.
3. Hands-on practice with online equipment.
4. Written examinations.
5. Electronic files of training material

C. Video imaging training sessions shall be made available to the University at no additional costs on DVD.

END OF SECTION
SECTION 08800 – GLAZING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:

A. General: As specified in Section 01001.

1.02 SUMMARY:

A. Section Includes:

1. Exterior glass.
2. Interior glass.
3. Glazing requirements.

B. Related Sections:

1. Division 1 Sections.
2. Division 8 – Hollow Metal Doors & Frames.
3. Division 8 – Glazed Aluminum Framing Systems.

1.02 DEFINITIONS:

A. GL-#: Numbered acronym specifying specific characteristics required for each monolithic glass pane.

B. LG-#: Laminated glass units. Units are made up of two or more layers of glass panes, e.g. GL-# and SG-#, with PVB or other scheduled plastic film interlayers between and which may additionally incorporate Low-E coatings in one of the inner surfaces.

C. IG-#: Insulated glass units. Units are made up of any combination of glass types, e.g. GL-#, LG-# and SG-#, and separated by an air space or gas filled space.

D. SG-#: Specialty glass units. Examples include spandrel glass, fire rated glass, cast glass, and sand etched glass or other panel materials; in monolithic or other assembled form.

E. Glass Unit Types: May be a specific specified GL-#, LG-#, IG-#, SG-# or any combination of these as scheduled for each glazed condition. Refer to "Schedule" paragraphs at end of these specifications and those indicated on the Drawings.

TECHNICAL SPECIFICATIONS
Glazing
Project No. SW-12-6238
08800-1
F. **Interior Glass:** Locational reference for any specific type of scheduled glass unit which is located within the exterior envelope (interior) of each structure and is not part of the exterior envelope glass unit assemblies.

1.03 **SYSTEM DESCRIPTION - PERFORMANCES - TYPICAL ALL UNITS:**

A. **Conditions for Performances:** Work to comply with the Code and Industry Standards cited herein when applicable to each work. Where differences occur between cited standards and specified requirements that are applicable to the Project requirements, comply with the standard or specification resulting in the highest quality without jeopardizing any other performances.

B. **The Code:** IBC 2006.

C. **GANA Publications:**

D. **IGMA Publications:**
   1. **SG-1000:** Structural Limitations of IG Units Under Uniform Loads.
   2. **SG-2000:** Making a Difference in Glass Deflection / Image Distortion.
   3. **TD 03-1003:** Construction Site Protection & Maintenance of Architectural Glass.
   4. **TM-1200:** Guidelines for Commercial Insulating Glass Dimensional Tolerances.
   5. **TM-1201:** Sealant Manufacturers Minimum Sealant Dimensions & Placement Survey.
   7. **TM-2100:** Recommended Voluntary In-Plant Test Methods & Performance Criteria for Sealed Insulating Glass Units.
   8. **TM-2301:** Voluntary Test Methods & Voluntary Performance Quality Assurance Criteria for Two Component Polysulfide Sealants Used in Manufacturing Sealed Insulating Glass Units.


12. **TM-4100**: Preventing Insulating Glass Failures.

E. **Safety Glazing**: ANSI Z97.1 / 16 CFR Part 1201, Category I materials compliant for all work, unless otherwise acceptable to the Architect.

F. **Other Codes and Standards Affecting Glazing**:

   1. Other as specified herein.
   
   2. As specified in Division 8 - Glazed Metal Framing Systems Section.

1.04 **SYSTEM DESCRIPTION – PERFORMANCES - EXTERIOR GLASS UNITS**:

A. **Solar and Thermal Performances**:

   1. **Standards**: Manufacturer's performance properties to be based on the following.
   
      a. **Solar Heat Gain Coefficient (SHGC)**: NFRC 200 methodology using LBNL-35298 Window 5.2 computer program.
      
      b. **Summer U-Value**: NFRC 100 methodology using LBNL Windows 5.2 computer program.
   
   2. **Performance Values for Curtain Walls**:

      a. **Shading Heat Gain Coefficient**: 0.24 maximum.
      
      b. **Summer U-Value**: 0.27 maximum.
   
   3. **Low-E Coating**: Where required to meet solar or thermal, or both, performances, comply with the following.

      a. **General**: ASTM C 1376.
      
      b. **Type**: Pyrolitic or sputter coat as selected by Glass Manufacturer for overall performances for each assembled glass unit required for the Project.
      
      c. **Exposure**:

         1) Do not expose any Low-E coating directly to exterior air, e.g. most outer surface of glass unit and on either side of glass unit.
2) Delete coating from the sealed edge to seal coating within each unit. Deletion to be straight, uniform and only enough to avoid each seal.

d. Reflectivity: Coating based on PPG "Solarban 60" Low-E coating. Comparable coatings not to have a reflectivity greater than this.

B. Windload Performances:

1. Design Criteria: IBC 2006, 105 mph, Exposure B, Importance Factor 1.0; with windload pressures adjusted for height and exposures in accordance with the Code.

2. Glass Retainment: Each lite is not to exceed 1” maximum deflection and under design loading; nor is glass bite to be reduced below 75% of the designed bite dimension. Larger deflections may be provided, when following conditions are confirmed in writing.

   a. No jurisdictional code requirements limiting deflection.
   
   b. Where Glazing Manufacturer accepts responsibility of performance for their recommendations.
   
   c. Engineering shows that deflection of that magnitude is possible without breaking.
   
   d. Engineering shows that glass can be retained in each scheduled metal framing. Written supporting confirmation is submitted from affected Glazed Metal Framing Manufacturer.
   
   e. Edge Support: Engineer and coordinate perimeter framing to ensure that edge support is adequate for required performances.
   

3. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under Code required windload duration.

C. Seismic Performances: IBC 2006 requirements as specified on Structural Drawings.


1.05 SUBMITTALS:

A. Product Data: Submit each Glazing Manufacturers' technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions.
B. **Shop Drawings:** Submit drawings required for proper fabrication and installation of each work. In addition to other requirements, show not less than following.

1. Show glass pane make-up with each unit type.
2. For each glass type, show sizes, configuration and glazing materials.
3. For each glass type, show relationship to each framing rabbet conditions, e.g. glazing materials used, glazing thickness, bite required and glass to rabbet edge clearance.

C. **Samples:**

1. **Glass Units:** Submit 8-1/2" x 11" samples of each type of glass unit type required for this Project, except for GL-2 clear glass where used as a monolithic pane.
2. **Glazing Materials:** If requested by Architect, submit samples for review.

D. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraphs herein.

1.06 **QUALITY ASSURANCE:**

A. **Performances Qualifications:**

1. **Assemblies:** It is the Manufacturer's and Fabricator's responsibility to determine the best way to achieve the specified composite performances within any restrictions as required herein and affected by products to be glazed.

2. **Tested Performances:** Where the Manufacturer can certify performances for criteria that requires testing by the Code or Industry from other comparable test data, then such data and certification will be acceptable when submitted in writing to the Architect; otherwise the Manufacturer or Fabricator, or both, must test all un-tested conditions.

B. **Manufacturer Qualifications:**

1. **Manufacturer Vs. Fabricator:** Where the Manufacturer is not the Fabricator, the Fabricator is to meet the same Qualifications as the Manufacturer and is used synonymously herein to mean the primary Entity that has sole responsibility of providing the final glass types for this Project that meet the Contract requirements.

2. **Manufacturing Experience:** Ten (10) continuous and current years manufacturing and fabrication glass specific experience with capability of providing all required glass product types for this Project
and meets manufacturing and fabrication conditions stated in current ANSI/ASQC 9002.

3. **Distribution:** Distributes glass products nationally across the U.S. to all regions. Regional Manufacturers are acceptable when distribution includes at least two regions of which one is the West or East coast.

C. **Product Source Responsibility:** Refer to Division 1 requirements.

D. **Engineering:** For exterior glazed products, comply with following.

1. **Submittal:** Submit Glass Manufacturer's recommended engineering design to meet specified Project performances.

2. **Coordination:** Coordinate engineering design with door and window framing manufacturers to ensure composite performances meeting Project design requirements.

3. **Glass Configurations:** Other exterior glass assemblies other than specified herein may be provided for Project to achieve specified performances when following is accomplished.

   a. Submitted engineering documentation is provided that is acceptable to Architect and approved prior to Bid.
   b. Glass configuration can be accommodated by each glazed metal framing system for which each glass type is scheduled.
   c. Light transmittance, glass transparency and color is not significantly altered and is acceptable to Architect.

E. **Performances:** Regardless of whether single monolithic, laminated or insulated glazed units are shown, provide units capable of meeting specified performances. Coordinate glazing requirements with framing to ensure composite glass and framing performances.

F. **Labels:** Label glass products designating type and thickness of glass. Provide Authority acceptable labels where safety glazing required.

G. **Laminated Glass and Glazing Method:**

1. No glazing method to affect long term structural performance of laminated glass, e.g. delamination. Where this can occur, notify Architect prior to purchase and manufacture of any such glass units for Project and do not proceed until securing Architect's directive.

2. No laminated glass edge to be exposed to view where glazing method can cause visual, non-structural edge delamination. Glazing method fully concealing such conditions are acceptable.

H. **Sealant Testing Reports:** Submit compatibility and adhesion testing reports from the Sealant Manufacturer indicating required Project adhesion and
compatibility with each Project glass type and scheduled glazing materials for each glass type.

I. **Mockups of Exterior Glass Work:** For each glass type, provide a mockup with each scheduled framing. Coordinate with each Framing Product Manufacturer and as specified in Division 8 - Glazed Metal Framing Section.

1.07 **WARRANTY:**

A. **Manufacturer's Warranty:** Submit written and executed Glass Manufacturer's "Manufacturing Defects Warranty" for following manufacturing defects and for following periods from date certified by Architect for Substantial Completion of the Project.

1. **GL-# (with Low-E Coating) Warranty:** Warrant low-E coating free of defects, e.g., peeling, cracking, discoloration or other deterioration, for ten (10) years minimum.

2. **SG-# (Fire Rated Ceramic Glass) Warranty:** Warrant glass free of defects for "Life of the Installation".

3. **LG-# (Laminated Glass) Warranty:** Warrant glass free of defects, e.g., edge separation, obstruction of vision, discoloration and blemishes exceeding those allowed by ASTM C 1172, for five (5) years minimum.

4. **IG-# (Insulated Glass) Manufacturer's Warranty:** Warrant glass to be free from vision obstruction due to infiltration of vision obstructing materials, e.g. moisture, dirt, dust, flaking, peeling or formation of any film into the air space for period of ten (10) years minimum.

5. **FT (Fully Tempered) Glass:** Warrant FT glass panes for five (5) years against breakage from nickel sulfide (NiS) inclusions that exceed 0.5% (5/1000).

6. **Structural Sealant Warranties:** Submit required Warranties for sealants specified in Division 8 - Glazed Metal Framing Section where Glazing Manufacturer is responsible for warranted conditions indicated by each Warranty. Where responsibility is only portion of structural glazing sealant warranty, specify extent of responsibility in each warranty.

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**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. **Acceptance Conditions:** Subject to compliance with requirements, one of the available Manufacturers may be provided when comparable products
are acceptable to the Architect. In addition to any other performances, appearance and reflectivity is critical and must meet the Architect's requirements for acceptance.

B. **Available Manufacturers:** One of the following.

2. Oldcastle Building Envelope.
3. Pilkington North America Inc.
4. PPG Industries.
5. Viracon, Inc.

2.02 **HEAT TREATED GLASS PRODUCTS:**

A. **Common Primary Characteristics:** Unless otherwise indicated, following to apply.

1. **Standard - Heat-Treated Glass:** ASTM C 1048.
2. **Type:** I (transparent glass, flat).
3. **Quality:** q3 (glazing select).
4. **Kind:** FT, except HS for missile impact glass panes.
5. **Glass Thickness:** Unless greater thickness is required to achieve performances, each glass pane is not to be less than following.
   a. **Laminated Glass Unit Assembly:** 1/8" minimum.
   b. **Monolithic Glass Units:** 1/4" minimum.

B. **GL-1:**

1. **Description:** Tinted glass.
2. **Primary Characteristics:**
   a. **General:** Complies with Paragraphs at 2.02-A.
   b. **Condition:** A (uncoated surface).
   c. **Class:** 2 (tinted and heat-absorbing).

C. **GL-2:**

1. **Description:** Clear glass with Low E coating.
2. Primary Characteristics:
   a. General: Complies with Paragraphs at 2.02-A.
   b. Condition: A (uncoated surface) or C (other coated surfaces) as required to meet performances. Condition C to be Low-E coating.
   c. Class: 1 (clear).

D. GL-3:
   1. Description: Clear glass.
   2. Primary Characteristics:
      a. General: Complies with Paragraphs at 2.02-A.
      c. Class: 1 (clear).

2.03 SPECIALTY GLASS PRODUCTS:
   A. General: Not required.

2.04 GLASS FABRICATION - GENERAL:
   A. General: Fabricate glass to sizes required for glazed openings and other glass work as indicated, with edge clearances and tolerances to ensure performances of the installed glass in the scheduled work.
   B. Fabrication Process – Individual Glass Units:
      1. Heat Treated Glass Products: Manufacture by float process. Distortions are to be within acceptable Industry standards.
      2. Specialty Glass Products: Not required.

2.05 GLASS FABRICATION - ASSEMBLED HEAT TREATED GLASS PRODUCTS:
   A. Laminated Glass Unit Assemblies:
      1. Description: Multilayered glass or plastic panes laminated on each side of optically clear plastic film interlayer(s), e.g. pvb (polyvinyl butyral), polyurethane and eva (ethylene-vinyl acetate), as required to achieve specified composite Project performances scheduled for each glazed opening.
3. **Types Required:**
   a. **LG-1:** Made up of the GL-2 and GL-3 panes for exterior glazed framing systems, see "Schedule" paragraphs for restrictions on its use.

4. **Overall Laminated Unit Thickness:** As engineered for performances and capable of fitting the framing glazing rabbet for which each unit is scheduled for.

5. **Glazing Restriction:** Use only in framing that captures each glass unit in glazing rabbet on all four sides. No glazing sealants are to come into contact with any edges. Notify the Architect in writing where a drawn condition is shown that would jeopardize this restriction.

6. **PVB Interlayer Characteristics:**
   a. **Performance - General:** As required to meet assembled glass performances specified herein, e.g., for wind, seismic and missile impact.
   b. **Performance - Ultraviolet:** Screens 90% minimum.
   c. **Performance - Hygroscopic Reduction:** For glass fabrications using pvb with edges exposed to the weather, provide tested products showing satisfactory long term reduction of hygroscopic nature of pvb. Saflex IIIIG products applicable to the Project requirements or comparable product acceptable to the Architect.
   d. **Thickness:** 0.060" thickness minimum.
   e. **Color:** Clear.

B. **Insulated Glass Units:**

1. **Standards:** ASTM E 2190, IGCC certified.

2. **Description:** Sealed insulated glass units combining monolithic glass panes or laminated glass units, or both, separated by an air space as required to meet the specified Project performances for each glazed opening and complies with the following.
   a. Can be incorporated into the framing glazing rabbet for which each insulated glass assembly is scheduled for.
   b. Where Low-E coating is required as part of an insulated glass assembly, comply with "System Description" paragraphs herein.
3. **Types Required:** INSUL-1 to be made up of following configuration, unless otherwise acceptable to the Architect.

   a. GL-1 on exterior air facing side.
   b. Air space.
   c. LG-1 on interior air side.
   d. Low-E coating on LG-1 assembly on #3 (preferred), #4, or #5 surface (position relative to the total insulated glass assembly) as required to achieve overall solar performances.

### 2.06 PRIMARY SEALS:

A. **Non-Rated Assemblies:**

   1. **Exterior Systems:** Glazed Metal Framing Systems Manufacturer’s structural silicone wet sealed system capable of meeting specified performances, unless dry glazed systems can be engineered for required performances.
   2. **Interior Systems:** Glazed Metal Framing Systems Manufacturer’s standard dry glazing gaskets and sealing materials.

B. **Fire Rated Assemblies:** Not required.

### 2.07 SETTING MATERIALS:

A. **Non-Rated Assemblies:**

   1. **Setting Blocks:** ASTM C 864, neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness.
   2. **Edge Blocks:** ASTM C 864, neoprene, EPDM or silicone blocks as required for compatibility with glazing sealant, of size and hardness required to limit lateral movement (side-walking) of glass.

B. **Fire Rated Assemblies:** Not required.

### 2.08 MISCELLANEOUS MATERIALS:

A. **Cleaners/Primers:** Type recommended by Glass and Gasket Manufacturer for required application.
3.01 EXAMINATION:
   A. **Verification of Conditions:** Inspect work of installed glass framing for proper installation tolerances, squareness, offsets at corners; for presence and functioning of weep systems when required; for existence of minimum required face or edge clearances; and for effective sealing of joinery. Do no allow glazing work to proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION:
   A. **Framing System:** Clean glazing channels and other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to substrates.

3.03 GLAZING:
   A. **Manufacturer's Instructions:** Comply with combined printed recommendations of the Glass Manufacturers and the Framing System Manufacturer to ensure required performances of the system.
   B. **Protections:** Protect glass from edge damage during handling and installation.
   C. **Setting/Edge Blocks:** Install in conformance with GANA recommendations. Set blocks in thin course of sealant which is acceptable for heel bead use.
   D. **Glass:** Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics. Replace damaged or defective glass, including those with edge damage.
   E. **Seals:** Glaze systems as follows.
      1. **Exterior Glazing:** Glazing methods complying with Project engineered performances.
      2. **Interior Glazing:** In accordance with Project related requirements successfully reviewed in submittals by Architect. Fire rated assemblies to match Manufacturer’s tested assemblies applicable to each rated glazing assembly.

3.04 PROTECTION AND CLEANING:
   A. **Protections:** Protect exterior glass from breakage immediately upon installation by use of crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove nonpermanent labels and clean surfaces.
   B. **Final Cleaning:** Refer to Division 1 requirements.
3.05 SCHEDULE:

A. Exterior Glass Assemblies:
   
   1. Typical: INSUL-1 meeting performances.
   
   2. Exceptions: LG-1 may be used in lieu of INSUL-1 where glazed framing rabbet is not capable of incorporating the Insulated units. LG-1 units to meet the same performances required for all exterior glass assemblies.


END OF SECTION
SECTION 08995 – GLAZED METAL FRAMING SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Aluminum entrance doors.
      2. Aluminum fixed windows.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 7 – Moisture Protection – Common Work Results.
      3. Division 7 – Flashing & Sheet Metal.
      5. Division 8 – Glazing.
      6. All Sections covering adjacent abutting work impacting work of this Section.

1.03 DEFINITIONS:
   A. General Comment: The definitions hereunder is not Industry definitions for the various types of windows included in each definition, but affords the Specifications Writer the ability to classify similar performances required of the windows under each definition type. Refer to the Drawing Schedules for the actual types required.
   B. Projected Vents: Use of word herein is defined to include any window with an operable vent that projects out from primary plane of window frame, e.g. casement, hopper, awning, projected, dual action, and pivoted windows, of which the actual types are scheduled and indicated on the Drawings. Required performances for these windows to strictly comply with actual definition for each type of “projected vent” as defined in current ANSI / AAMA / WDMA 101 / I.S. 2 / NAFS in effect.
   C. Sliding Vents: Use of word herein is defined to include any window with an operable sliding vent that remains within primary plane of door and window frame, e.g. horizontal sliding, single hung, and double hung, of which the
actual types are scheduled and indicated on the Drawings. Required performances for these sliding doors and windows to strictly comply with actual definition for each type of “sliding vent” as defined in current ANSI / AAMA / WDMA 101 / I.S. 2 / NAFS in effect.

1.04 SYSTEM DESCRIPTION - PERFORMANCES - GENERAL:

A. Conditions for Performances: Work to comply with the Code and Industry Standards cited herein as applicable to each work. Where differences occur between cited standards and specified requirements that are applicable to the Project requirements, comply with the standard or specification resulting in the higher quality without jeopardizing any other performances.


C. AAMA Publications:

1. General: All storefront publications as listed in their current publication catalog.


D. Other Codes and Standards Affecting Glazed Metal Framing Work:

1. As specified in Division 7 - Flashing & Sheet Metal Section.

2. As specified in Division 7 - Joint Sealers Section.

3. As specified in Division 8 - Glazing Section.

4. Surfaces where glazed metal framing terminate against.

1.05 SYSTEM DESCRIPTION - PERFORMANCES - EXTERIOR SYSTEMS:

A. General: Tested performances to apply to the actual work. Where any tested performance does not apply, notify the University prior to the purchase and manufacture of any products for the Work.

B. The Code:

1. Windload: 105 mph base wind speed, Exposure B, Importance Factor 1.0; adjusted as required for exposure and height above grade.

2. Seismic: As required by the Code with criteria indicated on the Structural Drawings.
C. **Structural:** In addition to structural performances required to meet missile impact performance, assemblies to be tested and comply with following.

1. **Uniform Load Structural:** 150% of positive and negative wind load design pressures

2. **Uniform Load Deflection:**
   a. **Vertical Members:** L/240 deflection maximum, unless L/175 allowed by Code or cited Industry standards for any span condition.
   b. **Transverse Members:**
      1) **Normal to Plane:** L/175.
      2) **In Plane:** L/360 or 1/8”; whichever is less.

3. **Load Combinations:** ASCE 7, current edition, unless any Code restrictions results in a higher quality.

4. **Glazing Disengagement:** No results to jeopardize disengagement of glass units in accordance with Division 8 - Glazing Section requirements.

5. **Testing:**
   a. **Test Method:** ASTM E 330.
   b. **Test Results:**
      1) No materials failures, structural distress and permanent deformation exceeding 0.2% of clear span.
      2) Operable units are still operable under static air pressure test.

D. **Missile Impact:** Meet IBC 2006 requirements for large missile complying with ASTM E 1996 and ASTM E 1886 as a glass and framing assembly.

E. **Thermal Movement:** Assemblies to be tested and comply with following.

1. **Temperature Change at Material Surface:** ±100°F minimum when installed surface temperature is 70°F.

2. **Test Method:** AAMA 501.5.

3. **Tested Results:** No buckling, stress on Project glass unit types, sealant failure, excess stress on framing, anchorage and reduction in any other required performances.
F. **Weather - Air Infiltration:** Assemblies to be tested and comply with following.

1. **Test Method:** ASTM E 283 at 6.24 psf static air pressure differential.
2. **Test Results:**
   a. **Framing:** 0.06 cfm/sf maximum.
   b. **Swing Entrances:** 0.50 cfm/sf maximum for single door and 1.0 cfm/sf maximum for pair of doors.
   c. **Windows:** 0.10 cfm/sf maximum.

G. **Weather - Water Infiltration:** Assemblies to be tested and comply with following.

1. **Test Method:** ASTM E 547 and ASTM E 331 with no uncontrolled leakage at following static air pressure difference.
2. **Test Result:** 12 psf minimum or higher tested results for all product types.

H. **Operational Force:** See requirements hereunder.

I. **Security:**

1. **Deglazing:**
   a. **Test Method:** ASTM E 987.
   b. **Test Result:** Panel members do not move more than original glazing bite under 50 lbf load applied to any stile and rail.

2. **Forced Entry:** Passes AAMA 1302.5 for swing doors.

1.06 **SYSTEM DESCRIPTION – PRIMARY DIMENSIONAL DESIGN REQUIREMENTS:**

A. **General:**

1. **Indicated:** Dimensions indicated are maximum requirements.

2. **Lesser Dimensions:** Engineered systems meeting all specified performances with lesser dimensions may be provided when acceptable to the University.

3. **Product Dimensional Variations:** Slight dimensional variations are allowed from those indicated hereunder where dimensions are greater. Sightline restrictions are more restrictive, e.g. ±1/8" maximum. Depth requirements are less restrictive, e.g. ±1/2", when generally being capable of being incorporated into the opening.
without significantly affecting the design. All dimensional variations are to be approved in writing from the University prior to the manufacture and purchase of any Project products.

B. Storefront Framing – Exterior:
1. **Sightline**: 2-12”.
2. **Depth**: 5”. Deeper depth may be incorporated when capable of being incorporated into the opening without affecting

C. Storefront Framing – Interior:
1. **Sightline**: 2”.
2. **Depth**: 4.5” minimum.

D. Swing Entrances:
1. **Style**: Medium Stile.
2. **Vertical Stile**: 3-1/2”.
3. **Top Stile**: 3-1/2”.
4. **Bottom Rail**: 10” height minimum.

E. Windows - Fixed:
1. **Sightline - Typical**: 2-1/8”.
2. **Depth**: 3-9/16”.

1.07 **SUBMITTALS**:

A. **Product Data**:
1. **General**: Submit comprehensive data, including standard product description and details, accessory materials required, and testing data confirming specified performances for actual Project assembly sizes.
2. **Structural**: Submit engineering by Manufacturer showing composite glass and framing structural performances for each framing installation.

B. **Shop Drawings**: Submit comprehensive dimensioned, to scale, and detailed Drawings required for proper fabrication of glazed metal framing systems.
C. **Samples:** Submit following.

1. **Components:** For review of appearance, size and configuration of components, submit samples of primary components in profile x 11" size. Include each coping, sill and solar louver.

2. **Finishes:** For review of each finish, submit Project representative finishes on Project metal equivalents.

D. **Quality Assurance Submittals:** Submit in accordance with "Quality Assurance" paragraphs herein.

E. **Closeout Submittals:** Refer to “Warranty” and “Maintenance” paragraphs herein.

**1.08 QUALITY ASSURANCE:**

A. **Exceptions to Compliance with Division 7 – Moisture Protection – Common Work Results:**

1. **Third Party Review:** Is not required.

2. **Technical Representative:** Is not required, where Installer is approved in writing by the Manufacturer as having the requisite experience and skill necessary to provide watertight assemblies in accordance with the Manufacturer’s Project specific requirements.

B. **Exterior System Source Responsibility:** Unless otherwise acceptable to the University, provide single source responsibility for the engineering, design, testing, fabrication and installation into integrated systems for all the following primary components.

1. **Framing:** All product forms.

2. **Related Work:**
   
   a. Glass and glazing work.
   
   b. Sealant work.
   
   c. Anchorage.

C. **Project Assemblies and Performances:**

1. **Intent:** Specified performances are applicable to the actual Project assemblies, e.g., each type, size and configuration. Where Manufacturer’s engineering or existing tested assemblies, or both, are not applicable to actual Project conditions, one of following may be accomplished, subject to acceptance by the University and prior to purchase and manufacture of any such Project units.
a. Manufacturer to conduct testing and engineering to confirm performances.

b. Manufacturer may provide similar units with engineering and testing that exceed required performances as long as any visual design intent changes are acceptable to the University.

c. Manufacturer may submit acceptance of performances based upon their engineering judgment with supporting engineering data.

2. **Submittal:** Submit written tested data and Manufacturer’s acceptance for all performances.

D. **Glazed Metal Framing Manufacturer Qualifications:** Submit written documentation of following.

1. **Experience:** Ten (10) current and continuous years minimum experience in manufacture and fabrication of products of types required for this Project and on Projects of similar scope and installation complexity.

2. **Manufacturing Assembly Capability:** Framing components to be fully manufactured in facilities owned by the Glazed Metal Framing Manufacturer with full capability to shop assemble the glazing and other related materials into unitized components, unless stick assembled systems are acceptable to the University.

3. **Installation Capability:** Maintains Factory trained Technicians capable of field installing the Project products. Manufacturing and installation capability to reside with the Manufacturer. Separate sourcing is not allowed.

4. **Sourcing:** Glazed Metal Framing Manufacturer may subcontract the manufacturing and installation work from another single source, for the manufacturing and installation work, when following occurs and when acceptable to the University.

   a. Glazed Metal Framing Manufacturer remains fully responsible as the primary source for all the work.

   b. Has experience coordinating successful Projects incorporating significant amount and range framing system types and where the total Project cost exceeded 100 million dollars and with at least one (1) such successful project completed every year over their ten (10) year minimum manufacturing experience or other comparable experience that is acceptable to the University.

   c. Subcontracted source is a contract under the primary Glazed Metal Framing Manufacturer.
d. Subcontracted source for manufacturing and installation also complies with the "Manufacturer Qualifications" for manufacturing experience, assembly capability and installation capability.

E. **Installation Experience:** In addition to other requirements specified herein, Glazed Metal Framing Manufacturer for exterior systems to comply with requirements specified in Division 7 - Common Work Results - Moisture Protection Section.

F. **Project Supervisor:** Each Product System Manufacturer to assign a full time Supervisor with not less than 8 years experience in installing products of types required for Project on successful projects of similar scope, list of comparable projects indicating system types installed and glazed framing photographs of at least three (3) comparable projects.

G. **Alloy Selection:** Specified alloy requirements are not meant to necessarily limit Glazed Metal Framing Manufacturer from selecting alloys offering best performances for the Project. Specified alloys are not to be less than those indicated, but others may be provided, subject to approval by the University. Regardless of selected alloy, final finished appearance to be consistent between all similar finished components.

1.09 **WARRANTY:**

A. **Manufacturer Warranty:** Submit written and executed standard "Manufacturing Defects" Warranty covering following from date established by the University for Substantial Completion of the Project.

1. **Structural Integrity:** Ten (10) years.

2. **Glass:** Five (5) years, unless ten (10) years where project glazing requires laminated glass and incorporates a Manufacturer approved interlayer.

3. **Hardware:** Three (3) years.

4. **Finish:** Ten (10) years.

B. **Installer's Warranty:** Submit Installer's "Installation Defects" Warranty for period of three (3) years which is in addition to any other installation defects, the watertight performance of the installed systems.

C. **Other Warranties:** As specified in Division 8 - Glazing Section.

**PART 2 - PRODUCTS**
2.01 PRIMARY METAL FRAMING SYSTEMS - EXTERIOR:

A. **Condition of Acceptance:** Subject to compliance with the requirements acceptable to the University, complying products from one of the specified Manufacturers.

B. **Available Manufacturers - Typical:**
   1. Arcadia:
   2. EFCO.

2.02 FRAMING – PRIMARY CHARACTERISTICS:

A. **Aluminum Extrusions - General:**
   1. **Alloy:** ASTM B 221, 6063-T5 alloy minimum and of other structural alloy when required to meet required performances for Project specific conditions of installation.
   2. **Primary Structural Contributing Cross Sectional Thickness:**
      a. **Standard:** ANSI H35.2.
      b. **Exterior Systems:** 0.080” to 0.125” as required to achieve performances.
      c. **Interior Systems:** Not required.
      d. **Exception - Exterior and Interior Systems:** Where primary components are required to be fastened, no cross sectional thickness to be less than 0.125” or provided with alternate concealed structural reinforcements.

B. **Brake Formed Work:** For brake formed special components, Glazed Metal Framing Manufacturer to recommend appropriate alloy type and gauge of metal to be utilized. Do not provide less than ASTM B 209, 5005 alloy, of 0.125” minimum thickness, unless other recommendations are acceptable to the University. Finish is required to match primary framing.

2.03 GLAZING:

A. **Glass and Related Glazing Materials, General:** Comply with Division 8 - Glazing Section.

B. **Glazing Gaskets:** Wet and dry glazing materials as required to meet specified performances as follows.
   1. **Wet Glazing Materials:** Structural silicone adhesive from Dow or Momentive; no other substitutions.
2. **Dry Glazing Materials:** Glazed Metal Framing Manufacturer’s EPDM, neoprene or silicone materials of hardness selected to meet Project performances and conforming to ASTM C 509 or ASTM C 864.

2.04 **SCREEN ASSEMBLIES:**

A. **General:** Not required.

2.05 **HARDWARE:**

A. **General:** Manufacturer’s recommended products for each Project opening application and performances. Products to be Manufacturer’s heaviest commercial hardware units; unless otherwise acceptable to the University. Indicated hardware hereunder is primary units; provide hardware and reinforcements as required to complete functional use of each opening.

B. **General:**

1. **Standard:** Complies with AAMA publications 900 series requirements as applicable to each hardware type.

2. **Muntins:** For units indicated, provide standard surface applied muntin grid each side of the glass. Insulated glass units to be provided with internal air space spacers matching muntin grid design.

3. **Weatherstripping:** Provide full perimeter for all doors and windows with operable vents.

C. **Entrance Doors:** As scheduled in Division 8 - Hardware Section.

D. **Fixed Windows:** Not applicable.

E. **Finishes:**

1. **General - Metals:** Where not specifically specified, provide hardware with finish color matching each adjacent primary framing finish for which each hardware scheduled.

2. **Painted Finishes:** Manufacturer’s standard high performance paint finish, e.g., urethane, fluoropolymer, powder, or epoxy, matching each primary framing color for which each hardware scheduled.

2.06 **RELATED MATERIALS/COMPONENTS:**

A. **Internal Reinforcements:** Structural aluminum wherever possible; where not possible then AISI Type 304 stainless steel.

B. **Anchorage Devices:** AISI Type 300 series alloy stainless steel devices, except fasteners for fastening work attached to any primary structural steel framing to be galvanized steel. Exposed to view fasteners to be provided with paint coating of color matching primary framing finish.
C. **Sealant Work:**

   1. **Structural Sealants:** Silicone products as selected by Glazed Framing System Manufacturer for engineered performances.

   2. **Other Joint Sealing:** Provide silicone of types specified in Division 7 - Joint Sealers Section.

D. **Electrolytic Barrier Coating:** Bituminous paint, SSPC - Paint 12, and zinc chromate; or other Glazed Metal Framing Manufacturer recommended product acceptable to the University.

2.07 **PRIMARY FRAMING FINISHES - FACTORY APPLIED:**

A. **General:** Comply with Division 5 - Shop Applied Finishes for Metal Section. Color as scheduled.

B. **Fluoropolymer Color:** Color as scheduled.

C. **Anodized Color:** Clear.

2.08 **FABRICATION:**

A. **General:** Fabricate system in compliance with Manufacturer's requirements to conform product to Project specific conditions of exposure and performances, including thermal and structural movement performances required; as fully submitted and successfully reviewed by the University.

B. **Extent of Shop Fabrication:** Work to be fully shop fabricated to the greatest extent possible, but not less than following.

   1. Window units fully shop fabricated with no component field fabricated without the University's knowledge.

   2. Door panels fully shop fabricated. Field assembly of door jambs, heads and sills may be field assembled, unless not standard or approved in writing by the Manufacturer.

C. **Anchorage and Welding Exposure:** Design for concealed fasteners and welding, including those required in the field. If exposed conditions are required, such conditions will be allowed when meeting following criteria.

   1. Where no other solution is possible.

   2. Where any required performance cannot be achieved by other means.

   3. When such conditions are made known to the University and excepts exposure conditions, prior to purchase, manufacture and fabrication of any work.
D. **Reinforcements:** Reinforce work as required for engineered structural and anchorage performances.

E. **Weeps:** Provide weeps in accordance with cited standards.

F. **Field Work Accommodation:** Allow for field adjustments. Properly mark products for efficient field assembly.

**PART 3 - EXECUTION**

**3.01 EXAMINATION:**

A. **Verification of Existing Conditions:** Verify that existing conditions have been built to tolerances necessary to ensure system performances. Do not begin work where tolerances are not in conformance with requirements or where work cannot be accommodated to ensure performances required.

**3.02 INSTALLATION:**

A. **General:** Install each work in strict accordance with the Glazed Metal Framing System Manufacturer's Project specific requirements as fully submitted and successfully reviewed by the University.

B. **Work Forces:** Accomplish work by the Glazed Metal Framing Manufacturer's experienced and skilled personnel capable of producing work in conformance with the Contract intent.

C. **Workmanship:** Erect plumb and true, and in proper alignment and relation to required lines and grades as required. Accurately fit all work. Anchor securely to adjacent work. Allow for proper expansion and movement of assembles. Do not obstruct weeps.

D. **Erection Tolerances:**

1. **Relative to Other Work:** Do not exceed following relative to other adjacent work and when the adjacent work meets their Project required tolerances for plumb, level and location.
   
   a. **Along Plumbed Length:** 1" in 100 feet.

   b. **From Level:** 1".

   c. **From Location:** 1".

E. **Dissimilar Materials Protection:** Apply electrolytic barrier coatings or other the University acceptable separating materials for following.

1. **Dissimilar Metals:** E.g. any different contacting metals. Stainless steel fasteners required to fasten aluminum components are excluded from this requirement as long as the mass relationship of the stainless
steel to the contacting metal meets NiDI requirements so electrolytic reaction is insignificant.

2. Other Materials: Contacting alkali containing substrates of concrete, masonry, portland cement plaster, and preservative treated wood surfaces.

F. Defective Work: Do not install damaged or defective work, including those with visually apparent scratched surfaces. Restoration work may be accomplished when acceptable to the University, otherwise replace with Contract complying work to satisfaction of the University.

3.03 FIELD QUALITY CONTROL:

A. Contractor Responsibility: It is the Contractor’s responsibility to meet specified performances regardless of whether field testing is required or not. The University reserves the right to field test units.

B. Costs for Testing:

1. Initial Testing: By the University.

2. Subsequent Testing: For non-compliant conditions, all costs assumed by Contractor; with no cost borne by the University. Subsequent testing to be performed until successful testing achieved.

C. Types of Testing and Results Required:


2. Air Infiltration: ASTM E 783 with allowable air infiltration not to exceed 1.5 times the specified performance level for each type of glazed metal system or 0.15 cfm per foot of crack length; whichever is greater.

3. Water Infiltration: ASTM E 1105 with no uncontrolled water leakage at two thirds of the laboratory specified water penetration pressure.


3.04 DEFECTS, CLEANING & PROTECTION:

A. General: Refer to Division 1 requirements.

END OF SECTION
SECTION 09100 – METAL SUPPORT ASSEMBLIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Non-loadbearing metal support systems.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 5 – Cold-Formed Metal Framing.
      3. Division 7 – Building Insulation.
      5. Sections with work built into metal framing systems.
      6. Sections with work to which metal framing attached to.
      7. Sections with work attached to metal framing.
      8. Sections with work penetrating final composite framed assemblies.

1.03 DEFINITIONS:
   A. Load Bearing Metal Support Systems: Cold formed metal framing assemblies supporting axial and/or transverse loads in addition to loads that may be directly attached to the framing; specified in Division 5 – Cold Formed Metal Framing Section.
   B. Non-Loadbearing Metal Support Systems: Cold formed metal framing assemblies supporting only loads directly attached to the framing and minor axial and/or transverse loading not greater than 8 psf; specified in this Section.
   C. Suspended Metal Support Systems: Cold formed metal framing assemblies, generally horizontal, characterized by wire hanger supports and supporting only loads directly attached to the framing; unless indicated on Structural Drawings, as specified in this Section.
1.04 SYSTEM DESCRIPTION:

A. Composite System Performance:

1. L/360 deflection maximum for all imposed loads, including point loads and 5 psf minimum transverse load.
   a. Supporting tile and stone finishes.
   b. Supporting architectural wall cabinets.

2. L/240 deflection maximum with 5 psf minimum transverse load.
   a. For all other finishes not requiring L/360 deflection.

B. Fire Rated Assemblies: All assemblies to be constructed as not less than 1 hour assemblies, unless higher rated assemblies are indicated.

1.05 SUBMITTALS:

A. General: Submit in accordance with Section 01300 - SUBMITTALS.

B. Product Data: Submit Manufacturer's standard publications with product descriptions for all materials and accessories required. Submit specific assembly requirements for each different composite assembly, including following.

1. Structural Performance Data: For each different assembly, submit data indicating gage and framing requirements based upon size of framing required, framing heights/configuration, composite assembly configuration, and structural performances required; including for sound isolation clips.

2. Fire Design Requirements: For each rated assembly, submit framing requirements which have been coordinated with requirements of materials forming composite assembly.

3. Sound Isolation Performance: Submit laboratory tested data for any indicated assemblies conforming to Manufacturer’s tested assemblies.

C. Quality Assurance Submittals: Submit in accordance with "Quality Assurance" paragraphs herein.

1.06 QUALITY ASSURANCE:

A. Structural Design: Engineer in accordance with American Iron and Steel Institute (AISI) "Specification for the Design of Cold Formed Steel Structural Members" or stricter requirements of local Codes and Authorities. Submit published data confirming required framing for each composite assembly condition.
B. **Fire Assembly Certification:** For each fire assembly, Installer to certify in writing that installed metal support systems are in conformance with types of assemblies required at each location, including for coordination with specific assemblies of other components affecting each fire assembly and for compliance with requirements of Code/Authorities.

C. **Coordination:**
   1. Ensure metal framing is provided wherever any work that would otherwise be only fastened to the gypsum board, unless otherwise acceptable to the University.
   2. For Division 7 – Exterior Insulation & Finish Systems Section, ensure gypsum sheathed products have framing along the full length of each board end.

D. **Other Metal Support Systems:** Other metal support systems are specified in other Sections including, but not limited to, following.
   1. Division 9 - Acoustical Ceilings: Direct hung systems, except Gypsum Board systems as specified herein.

E. **Proprietary Clips:** For vertical compensation and sound isolation, secure Manufacturer’s engineering of clip assemblies to ensure that supported work is structurally stable. Coordinate clips with each assembly condition required. Clips are not only for metal support work specified herein.

F. **Insulation:** Where assembly of metal support framing would prevent installation of Division 7 – Building Insulation Section insulation from being installed by that Installer and completing insulating intent, e.g. header beams, corner construction, double stud framing, and similar installations, provide same insulation required for Project as part of work of this Section. Fill entire cavities of such framing; unless otherwise acceptable to University.

G. **Recessed Products:** Provide deeper framing, if required for proper installation of recessed products, e.g. fire cabinets and toilet accessories. Where such adjustments is required, notify and secure the University’s acceptance prior to start of such work.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. **C-Shaped, Loadbearing and Non-Loadbearing Metal Support Systems:**
   One of following.
   1. ClarkWestern Building Systems.
   2. Cemco (California Expanded Metals Company).
3. Dietrich Metal Framing Inc.
4. Or pre-approved equal.

2.02 PRIMARY METAL SUPPORT SYSTEMS:

A. Typical Characteristics:
   1. **Type:** Cold formed, C-Shaped, punched metal framing.
   2. **Finish:** ASTM A 525, G-60 minimum, hot dipped galvanized.
   3. **Size:** 3-5/8".

B. Non-Loadbearing:
   1. **Type:** ASTM C 645.
   2. **Gages:** As engineered by Metal Support Manufacturer and successfully reviewed by University in submittals; but not less than following.
      a. **General:** 25 gage (0.0188" base metal).
      b. **Openings:** 20 gage (0.0312" base metal) minimum.
      c. **Supporting Tile and Stone:** 20 gage (0.0346" base metal) minimum.
      d. **Supporting Architectural Wall Cabinets:** 16 gage (0.0566" base metal) minimum.
      e. **Security Walls (With Security Lath):** 16 gage (0.0566" base metal) minimum.
   3. **Grade:** ASTM A 446, Grade A, 33 ksi minimum.

2.03 SPECIALTY PRODUCTS:

A. **Vertical Deflection Clips:** One of following.
   1. The Steel Network Inc. “VertiClips” line; galvanized G-60 finish.
   2. SSMA complying “Double Deflection Track” assembly.
   3. Or pre-approved equal.

2.04 RELATED MATERIALS:

A. **Runner Tracks:** Comply with same standards, size, gage, and finish as primary framing components of assembly.
B. **Furring Channels (Hat Shaped):** ASTM C 645, Fy = 33 ksi, 25 gage (0.0179" minimum base metal), nominal 3/4" depth x 2-1/2" overall width, ASTM A 525 minimum G-60 hot dipped galvanized.

C. **Cold Rolled Channels:** For stiffener reinforcement, 3/4" minimum depth, unless otherwise indicated, 16 gage (0.0598" minimum base metal), ASTM A 525 minimum G-60 galvanized or black asphaltum painted.

D. **Wire Ties:** ASTM A 641, soft, Class 1 galvanized, gage complying with UBC Chapter 47 requirements.

E. **Anchorage Devices:** Galvanized, screws, power actuated devices, and bolts of size, type, and spacing as recommended by the Metal Support Framing Manufacturer for type, sizes, structural performances, and other project specific conditions of use.

F. **Welding Material:** AWS D1.1, ASW D1.3, AISI Manual Section E2.

G. **Galvanizing Repair Paint:** ZRC Products Company “ZRC Cold Galvanizing Compound” or preapproved equal product.

**PART 3 - EXECUTION**

**3.01 METAL SUPPORT SYSTEMS, GENERAL:**

A. **Tolerances:**

1. **Load-Bearing Framing:** Installations not to exceed 1/8" in 10'-0" from required plane.

2. **Non-Loadbearing Framing:** Installations not to exceed 1/4" in 12'-0" from required plane.

3. **Suspended Ceiling Framing:** Installations not to exceed 1/4" in 12'-0" from required plane.

4. **Tile/Stone Finishes:** Installations to receive tile/stone finishes not to exceed 1/8" in 8'-0" from required plane.

5. **Variation from Location:** Each plane not to exceed required location by more than 1/2" from any point on plane.

6. **Spacing:** Each member to be not more than 1/8" maximum from required location.

B. **Spacing:** 16" o.c., unless wider spacing indicated.

C. **Span Limits:** Do not exceed design performance requirements for each composite assembly. For vertical assemblies generally carry to structure above; unless otherwise indicated. Where indicated to be carried above ceiling line, but not to structure above, carry not less than 12" above ceiling line and provide lateral supports.
D. **Lateral Support**: Provide types recommended and engineered (if required) by the primary Framing Manufacturer, but not less than specified herein.

E. **Coordination, Support Framing**:
   1. **General**: In addition to other coordination requirements with other Trades, coordinate support framing and anchorages required by other Installers. Installers of other work are responsible for the proper support of their work. Where arranged by other Installers, install supports and anchorages in accordance with their requirements.
   2. **Gypsum Board and Gypsum Board Sheathing**: Whether exterior or interior applications, provide supports under all otherwise unsupported ends. This requirement applies to other similar sheathing or board type materials.

F. **Control Joints**: Frame each side of control joints in manner to ensure performance of these joints and gypsum board assemblies.

G. **Anchorage**:
   1. **Non-Loadbearing Metal Support Systems**: Fastening of components is to be accomplished with screws, bolts, or welding or combination of these as required for proper structural performances.
   2. **Welding**: If required or used by Contractor, welded components to be not less than 16 gage steel material. Perform welding in conformance with AWS requirements. Welds and welding procedures to develop required strengths for structural performances. If any welded work reduces the amount of available metal to extent that University determines that such reduction could jeopardize the structural integrity of the framing, reinforce work as directed by University.

3.02 **LOADBEARING FRAMING**:
   A. **General**: AISI standards complying with requirements shown on Structural Drawings; as approved on Shop Drawings successfully reviewed by University.

3.03 **NON-LOADBEARING FRAMING**:
   A. **Standard**: Comply with following.
      1. Steel Stud Manufacturers Association publications.
      3. ASTM C 754.
   B. **Openings**:
      1. **Door Openings**: Double stud framing; complying with USG "Gypsum Construction Handbook" and following.
a. 3'-0" Wide or =100 Lbs 25 gage minimum.

b. >3'-0" Wide or >100 Lbs: 20 gage minimum.

2. All Other Openings: 20 gage minimum; double stud framing.

C. Vertical Compensation: Provide at studs taken anchored to structure.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Interior gypsum board assemblies.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 5 – Cold Formed Metal Framing.
      3. Division 9 – Metal Support Assemblies.
      4. Sections covering work impacting gypsum board assemblies.

1.03 DEFINITIONS:
   A. General: Gypsum Association GA-505.

1.04 SYSTEM DESCRIPTION:
   A. Interior Partition Assembly Height Restrictions:
      1. Load Basis:
         a. Supporting Lightweight Finishes: Limit deflection to L/240 maximum with 5 psf lateral load for partitions with light finishes similar to those with paint coatings and wall coverings.
         b. Supporting Heavy Finishes: Limit deflection to L/360 maximum with 5 psf lateral load for partitions with heavy finishes similar to tile and stone.
      2. Intent: Do not exceed any height for which composite assembly, e.g. application of gypsum board(s) on one side, with single layer each side, or double layer each side, that exceeds the Division 9 - Metal Support Assemblies Section Manufacturer's framing capability. If any such conditions exist, verify requirements from the University prior to the purchase and manufacture of any products affected by such assemblies.
B. **Fire Rated Assemblies:** All assemblies to be constructed as not less than 1 hour assemblies, unless higher rated assemblies are indicated.

1.05 **SUBMITTALS:**

A. **Product Data:** Submit for all materials and accessories required. Submit specific assembly requirements and recommendations for each type of installation, including structural performance, fire assembly, and impact data.

B. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraphs herein.

1.06 **QUALITY ASSURANCE:**

A. **Contractor Coordination:**

1. Ceiling Supported Units: Provide metal framing with spaced framing in accordance with Gypsum Board Manufacturer for each type of board to be supported by ceiling framing, but not greater than 12" o.c., unless otherwise approved in writing by Gypsum Board Manufacturer and acceptable to Architect.

2. **Supports:**

   a. **Board Ends:** Install solid framing members along ends of all gypsum board panels.

   b. **Equipment:** No work is to be supported in any manner by gypsum board panels; unless otherwise acceptable to University. Install framing members concealed behind gypsum board adequate to support such work.

   c. **Sag Prone Board Units:** Verify and provide additional supports to prevent sagging of units; as required by Board Manufacturer.

3. **Fire Assemblies:**

   a. **Submittal:** For each fire rated assembly required, submit data on materials and installation requirements of each assembly.

   b. **Certification:** Submit written certification from Installer certifying that fire rated gypsum board assemblies installed in strict compliance with current Code and Authority acceptable requirements.

B. **Telegraphing:** Not under any circumstances are subsurface conditions to unreasonably telegraph through final scheduled finishes under any environmental and lighting conditions and regardless of specified finish levels indicated. Adjust tolerances and finishing levels as required to best suit final applied finishes.
PART 2 - GENERAL

2.01 MANUFACTURERS:
   A. Gypsum Board and Related Products: All products from one of the following, unless otherwise acceptable to the University.
      1. CertainTeed Gypsum, Inc.
      2. Georgia-Pacific Corp.
      4. Or pre-approved equal.

2.02 GYPSUM BOARD PRODUCTS:
   A. General Primary Characteristics: Unless otherwise specified herein, provide in accordance with following.
      b. Thickness:
         1) Exposed Board: 5/8”.
         2) Sublayer Boards: Not required.
         3) For Radiused Installations: Not required.
      c. Size: Maximum available size to minimize end to end butt joints.
      d. Edges:
         1) Exposed Face Layer: Tapered or featured (beveled or round) at Contractor’s option.
         2) Sublayers: Not required.
   B. GB-1, Fire Resistant Boards: ASTM C 36, Type X, or FS SS-L-30d, Type III, Grade X, Class 1, Form a, Style 3.

2.03 SPECIALTY BOARDS:
   A. GB-2, Impact Resistant Boards:
      1. Impact Resistance: ASTM C 1629 tested performances as follows.
         a. Abrasion: Level 1 minimum.
         b. Indentation: Level 1 minimum.
c. **Soft Body Impact:** Level 2 minimum.

d. **Hard Body Impact:** Level 1 minimum.

2. **Fire Rated Assembly:** Where specified, boards are to be capable of being used in lieu of Type X.

3. **Mold:** ASTM D 3273, score of 10 (no growth) minimum.

2.04 **RELATED MATERIALS:**

A. **Joint Treatment Materials:**

1. **Typical:**
   a. **General:** ASTM C 475.
   b. **Joint Tapes:** Both of following.
      1) Cross fibered paper reinforcing tape for inside and outside corners and terminations abutting dissimilar construction.
      2) Fiberglass tape for field flat joints.
   c. **Joint Compound:**
      1) **Description:** Manufacturer's vinyl based products formulated for specific installation conditions.
      2) **Ready-Mix Type:** Two separate grades, one for taping/filling and one for topping sanding.
      3) **Setting Type:** Chemical setting compound.
   d. **Exception:** Treatment materials do not apply to “backer units”.

2. **Exception - GB-3 and GB-4:**
   a. **Tape:** Backer Manufacturer’s recommended fiberglass tape.
   b. **Joint Tape Embedment Material:** Use same scheduled tile setting material for embedment of tape.

B. **Gypsum Board Screws:**

1. **Types:** In accordance with USG “Gypsum Construction Handbook”.

2. **Interior Fasteners:** ASTM C 1002 and ASTM C 954; with corrosion resistant coating.

3. **Exterior:** Fasteners of types approved by Gypsum Board Manufacturer; except provide AISI 300 series stainless steel screws.
C. **Trim Accessories – Standard:**

1. **Materials:** Refer to “Installation” paragraphs herein for use schedule.
   
   a. **PVC:** ASTM D 3678. Plastic Components, Inc. or preapproved equal product.
   
   b. **Galvanized:** ASTM C 840.

2. **Primary Types:** ASTM C 840 and ASTM C 1047 galvanized steel types as follows or equivalent shapes in PVC as required by “Schedule” paragraphs.
   
   a. **Edge Bead:** L or LC shaped as required by conditions of each installation.
   
   b. **Corner Bead:** CB shaped.
   
   c. **Control Joint:** V shaped.

D. **Acoustical Sealant:** Not required.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. **Tolerances:** Ensure construction tolerances by other Trades are plumb, level, and accurately located.

B. **Metal Support Assemblies:** In addition to primary support framing, ensure following completed.
   
   1. Metal framing for subsequent wall or ceiling supported work by other Trades, e.g. equipment and fixtures.
   
   2. Metal framing for otherwise unsupported ends of gypsum board work.
   
   3. **Isolation:** Ensure that wall systems are properly isolated to ensure proper movement of assembly and to prevent loading which may damage the assembly.
   
   4. **Openings:** Ensure that openings are properly framed to support interfacing work and to avoid damage by impact loads to adjacent gypsum board.

C. **Fire Rated Assemblies:** Ensure that fire rated framing complies with type of composite assembly required for each condition.

D. **Insulation:** Ensure that insulation is installed prior to closure.
E. **Control Joints:** Ensure that support systems do not bridge control joints.

### 3.02 ASSEMBLIES – GENERAL:

A. **Standards:** Work to comply with current applicable requirements of following. Conflicting standards to comply with standard producing higher quality work applicable to each condition of installation.
   
   1. ASTM C 840 (all; except metal framing) and ASTM C754 (metal framing).
   
   

B. **Edges/Ends:**
   
   1. **Like Edges:** Position boards so like edges abut, e.g. tapered to tapered and square to square.
   
   2. **End-Butt Joints:** Minimize and locate as far from center of walls and ceilings as possible.
   
   3. **Staggering:** Observe cited standards staggering.

C. **Control Joints:** Types and locations as follows.
   
   1. **V-Shaped:** In field of panels. Fire rated joints to comply with GA-234.
   
   2. **Edge Trim:** Joint abutting dissimilar construction, 1/4" joint width or as otherwise shown.

D. **Anchorage:** Screw fastened panels and accessories.

### 3.03 INSTALLATION OF TRIM ACCESSORIES:

A. **General:** May be PVC or galvanized trims at Contractor's option. Use only one type throughout Project installations.

B. **Corner Beads:** Install at external corner of gypsum board work.

C. **Edge Trim:** Install edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed.

D. **Control Joints:** Install at required locations.

### 3.04 FINISHING:

A. **Gypsum Board Units:** GA-216 requirements and as specified in “Finish Levels” herein.
1. **Applies To:** Abutting field joints, termination trim flanges, inside corners, and fastener heads.

2. **Joint Compound Finish Quality:** Finish joint compound work to be smooth and feathered; so as not to telegraph through final Project finishes, e.g., paint coatings, wall coverings, etc.; regardless of whether work is lit by sunlight or lit by artificial light from Project light fixtures.

3. **Joint Tape:** Embed at all abutting field joints and inside corners of gypsum board work with joint compound in accordance with referenced standards; including prefill over which tape embedded and first coat over embedded tape. Taping is not required at terminations that receive gypsum board trim or joints concealed with trim by others. Taping embedment finish is in addition to and before installation of applicable finish “level” specified below.

4. **Finish Levels:**
   a. **Standard:** GA-214 finish levels; except as modified below.
   b. **Level 1:** For concealed spaces; including concealed spaces above suspended ceilings.
   c. **Level 2:** Not required.
   d. **Level 3:** Not required.
   e. **Level 4:** Exposed painted work up to eggshell sheen level.
   f. **Level 5:** Exposed painted work scheduled with semi-gloss or higher gloss sheen; if any.

3.05 **DEFECTS, CLEANING & PROTECTION:**

A. **General:** Refer to Division 1 requirements.

END OF SECTION
SECTION 09510 – ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Cast mineral fiber ceilings.
      2. Seismic braced performances.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 9 - Gypsum Board.
      3. Division 15 Sections.
      4. Division 16 Sections.

1.03 DEFINITIONS:

1.04 SYSTEM DESCRIPTION – CEILING PANEL SPECIFIC:
   A. Acoustical Performance:
      1. NRC: ASTM C 423, ≥0.70.
      2. CAC Range: ASTM C 1414, ≥35.
   B. Light Reflectance: ASTM E 1477, ≥86%.
   C. Fire Performance: ASTM E 1264, Class A.
   D. Durability:
   E. Health Related Performances: Meets following.
      1. Meets FGI Guidelines for cleanability.
2. Meets USDA and FSIS for use in food processing areas.

3. **Related Tests Performed:**
   a. **Washability:** ASTM D 4828 tested.
   b. **Scrubbability:** ASTM D 2486 tested.
   c. **Soil Resistance:** Tested to simulated supply air diffuser soiling test.

F. **Treatments:** Following is based on Armstrong World Industries treatments. Comparable treatments to have similar warrantable performances for acceptance by the Architect.
   1. **Dimensional Stability:** “HumiGuard Plus”.
   2. **Antimicrobial:** “Bioblock Plus”.

1.05 **SYSTEM DESCRIPTION – SYSTEM SPECIFIC:**

A. **Seismic Performance:**
   1. **System:** ICC AC156 tested systems meeting IBC 2006, seismic Site Class D performance.
   2. **Special Requirement:** System to be ICC-ES recognized for use of 7/8” exposed leg termination angle trim.

1.06 **SUBMITTALS:**

A. **Product Data:**
   1. **General:** Submit for all required products, including accessories and color charts.
   2. **Seismic Documentation:** Submit ICC ESR indicating compliance with requirements.

B. **Shop Drawings:** Submit. Show ceiling layout, relationship of work of other Installers, seismic details, support details of point loads, and other typical requirements to show coordination with Contract requirements and necessary for proper installation of systems.

C. **Samples:** Submit as follows for each required product.

   1. **Acoustical Units:** 8-1/2” x 11” samples, except scored units to be full size panel/tile samples.
   2. **Suspension System Components:** 11” lengths of main runners, tees, perimeter trim; with each required finish color.

D. **Closeout Submittals:** Refer to "Maintenance" paragraphs herein.
1.07 QUALITY ASSURANCE:

A. Layout: Center lights, mechanical grilles, and sprinkler heads within each Project tile or panel. Where any such work is not indicated to be so aligned, verify from University whether indicated alignment is required for Project.

B. Coordination: Contractor and Ceiling Installer to coordinate installation requirements of various Trades to ensure proper seismic bracing of ceiling systems and penetrating and attached elements; including but not limited to, following.

1. Mechanical work.

2. Electrical work.

3. Sprinkler and standpipe work.

4. Penetrating equipment, lights, and fixtures.

1.08 WARRANTY:

A. Manufacturer’s Warranty: For cast mineral fiber units, submit written and executed Manufacturer’s “Manufacturing Defects” Warranty for period of thirty (30) years from date certified by University for Acceptance of Project and based on not less than following.

1. Primary Coverages:

   a. General: Any defects due to manufacturing.

   b. Panel and Tile:

       1) No visible sag over warranteed period.

       2) Antimicrobial treatment stays active against gram-positive and gram-negative bacteria for warranteed period.

   c. Suspension System: Rust not to exceed 50% over warranteed period.

2. Primary Restrictions:

   a. Humidity: 90% maximum.

   b. Temperature Range: Not to exceed 60 ° – 104 ° F.

   c. Moisture: No water moisture exposure from other sources.

   d. Other: Free from exposures to chemical fumes and vibration.
1.09 MAINTENANCE:
   A. Extra Materials: For each size, type, and color of cast mineral fiber ceiling units furnish not less than 200 sf or 2% whichever is greater to University.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Available Products/Manufacturers: Subject to compliance with the requirements, design is based upon scheduled Manufacturer's products. Where any of the Manufacturer's below is not the scheduled the basis of design product, then products of the other Manufacturers below may be provided when pre-approved by the University.
      1. Armstrong World Industries.
      2. USG Interiors Inc
      3. Or other pre-approved equal.

2.02 CAST MINERAL FIBER UNITS:
   A. ACT-#:
      1. Product: As scheduled.
      2. Primary Characteristics:
         b. Face Size: Tile or panel in size as indicated.
         c. Thickness: As scheduled.
         d. Edge: As typical for each scheduled product. Where more than one profile available and edge is not scheduled, verify from the University and include impacts in the Bid.
         e. Classification: ASTM E 1264 characteristics as typical for each scheduled product.
         f. Color: Standard color to be selected by the University.

2.03 METAL SUSPENSION SYSTEMS:
   A. Product: For each scheduled ACT-#, provide the Acoustical Ceiling Manufacturer's recommended metal suspension system that is capable of complying with the specified requirements herein. Where more than one suspension is available and where such system is not scheduled, verify system to be provided from the University and include impacts in the Bid.
B. **Structural Class:**
   1. **Standard:** ASTM C 635.
   2. **Typical:** Heavy Duty, unless tested Intermediate Duty meets dead loads and seismic requirements.

C. **System Type:** Direct hung.

D. **System Components:**
   1. **General:** Provide complete systems capable of properly receiving required acoustical units. Components of system to include, but not necessarily be limited to, main runners, cross tees, perimeter trim, hanger wire, and anchorage devices.
   2. **Seismic Components:** Provide as required for Manufacturer's seismic tested assemblies, but not limited to, following.
      a. Compression posts.
      b. Spacer bars.
      c. Wall moldings.
      d. Hold down clips.
      e. Other specialty clips.
   3. **Perimeter Trim:** Manufacturer's standard profile designed for each Project product edge profile.

E. **Finishes:**
   1. **Metal Finish:** Manufacturer's standard base metal finish.
   2. **Painted Finish:** Suspension System Manufacturer's standard baked-on matte color matching acoustical panel color selected by University.

F. **Compatibility:** Provide system recommended for use by Acoustical Unit Manufacturer for acoustical unit type and project conditions of installation.

2.04 **ACCESSORIES:**

A. **Specialty Clips:**
   1. **Suspension System Related:** Manufacturer's specialty clips specifically engineered for anchorage of primary ceiling components to suspension system.
   2. **Hold-Down Clips:** Provide removable hold-down clips that are cable of holding down the ceiling panels to prevent small animals from pushing up on the ceiling boards and getting above the ceilings, e.g. Armstrong #414 clips.
B. **Anchorage Devices:** As required for seismic performances, but not less than five (5) times design load indicated in ASTM C 635, Table 1.

C. **Hanger Wire:** Galvanized carbon steel wire, ASTM A 641, soft temper, prestretched, Class 1 coating, sized so that stress at three (3) times hanger design load (ASTM C 625, Table 1) is less than yield stress of wire, but provide not less than 12 gage.

2.05 **MISCELLANEOUS MATERIALS:**

A. **Acoustical Sealant:** Where in an acoustically separated room, provide type recommended by Acoustical Ceiling System Manufacturer or other recommended and comparable product acceptable to the University.

**PART 3 - EXECUTION**

3.01 **INSTALLATION:**

A. **General:** Install each work in strict accordance with Manufacturer's Project specific requirements as fully submitted and successfully reviewed by University.

B. **Layout:** Layout units similar to Contract Drawings. Balance border widths at opposite edges of each ceiling area. Avoid use of less than half width units at borders.

C. **Metal Suspension Systems:**

1. **General:** Comply with Code compliant tested seismic systems as fully submitted and successfully reviewed by University.
   a. General field bracing details.
   b. Perimeter bracing.
   d. Field seismic separation joints.
   e. Penetrations, e.g. mechanical services and light fixtures.

2. **Tolerances:** Level 1/8" in 12'-0".

3. **Support of Heavy Penetrations:** Provide additional wire hangers and metal support framing at fixtures and other heavy penetrating work when required for structural support. Provide in conformance with Suspension System Manufacturer's project specific instructions.

4. **Edge Trim:** Install at terminations of ceiling installation. For rooms requiring acoustical performances, apply a continuous ribbon of acoustical sealant, concealed on back of vertical leg before installing trim.
D. **Acoustical Units:**

1. **General:** Install. Scribe and cut for accurate fit at borders and around penetrating work.

2. **Hold-Down Clips:** Apply number as required to hold entire perimeter from being pushed up from below from small animals.

3.02 **PROJECT COMPLETION:**

A. **Damaged Work:** All damages, deterioration, and abraded work is to be restored to University’s satisfaction or replaced with Contract complying work; prior to Final Acceptance by University.

END OF SECTION
SECTION 09610 – FLOORING TREATMENT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Moisture vapor transmission (MVT) floor treatments.
   2. Concrete alkalinity (pH) floor treatments.
B. Related Sections:
   1. Division 1 Sections, general.
   2. Division 1 – Unit Prices.
   3. Division 3 – Concrete Repair.
   4. Division 3 – Cast-In-Place Concrete.
   5. Division 9 – Resilient Flooring.
   6. Division 9 – Seamless Epoxy-Quartz Flooring.

1.02 SYSTEM DESCRIPTION:
A. MVT and pH Treatment Intent: Specified floor treatment products may not be required, unless tested MVT and pH actually exceed Manufacturer acceptable levels for each affected floor product. Provision for products are covered under Additive Bids required in Division 1 – General Requirements Section.
B. Performances: Flooring treatment is not required where following tested criteria are met, except where more restrictive criteria are required by the Product Manufacturer. Less restrictive criteria may be used when approved in writing by any affected Product Manufacturer, or where such criteria is published in the most current literature for any affected Project Product and only if such criteria are acceptable to the Architect.
   1. Moisture Vapor Transmission:
      a. Calcium Chloride Testing: For all substrate types, ≤3 lbs / 1000 sf / 24 hrs maximum.
      b. Relative Humidity Testing: 75% maximum.
2. Alkalinity: For cementitious substrates, surface alkalinity of pH 8 minimum to 9 maximum.

1.03 SUBMITTALS:

A. Product Data:

1. Test Procedures: Submit detailed data of each test procedures to be conducted.

2. Test Equipment: Submit data on each testing equipment.

B. Quality Assurance Submittals: Refer to “Quality Assurance” and “Field Quality Control” paragraphs herein.

C. Closeout Submittals: Refer to “Maintenance” paragraphs herein.

1.04 QUALITY ASSURANCE:

A. Approval of Flooring Treatment Products: If flooring treatment is required, submit the following written approval from each Product Manufacturer affected by this Flooring Treatment Specification Section.

1. Types of Acceptable Manufacturer Documentation:

   a. Approve each selected “specified” product for each flooring application.

   b. Submit alternate products selected and approved by the Manufacturer for each flooring application, unless otherwise acceptable to the Architect.

2. Conditions of Approval: Each Manufacturer approved flooring treatment product is an acceptance by the Manufacturer that the approved flooring treatment products are adequate to reduce the Project tested results at each area, where each flooring treatment product and their Project floor products are scheduled to be installed, to acceptable levels to ensure performance of their products for this Project.

B. Implementation of Testing:

1. Typical Intent: Testing to be implemented only after concrete slabs have been fully cured for the time periods as specified in the Concrete Sections and under the environmental conditions, e.g. concrete cured under in a fully enclosed condition and air-conditioning turned on for period to allow full moisture stabilization of the concrete as expected under Owner occupancy conditions.

2. Test Methods and Test Criteria: Testing methods and criteria herein applies to all moisture sensitive flooring, e.g. resilient flooring, wood flooring, carpeting, and related installation
materials, above the moisture transmitting substrate, unless otherwise indicated. Where any Manufacturer of any moisture sensitive flooring does not use the testing methods and criteria specified herein for evaluating MVT or pH sensitivity of their products, this shall be brought to the attention of the Architect during Bidding, but not later than before the signing of the Contract for this Project.

3. Restriction: Use of MVT membranes and testing is not to be used as a way to accelerate the Contractor’s Project progress, unless otherwise acceptable to the Architect. When allowed by the Architect, the Contractor, MVT Membrane Manufacturer, Flooring Manufacturer and Installer to jointly and severally accept and submit a written document accepting full responsibility, without dollar limit, for any trapped moisture defects arising out of using installed MVT membranes at any such location and is the cause of defects occurring in any construction and for a period of five (5) years after such MVT membranes have been installed. This warranty is in addition to any other warranties required MVT treatments.

C. Contractor Responsibility for MVT and pH Testing: At Contractor’s option, testing may be conducted as follows.

1. By qualified independent Testing Consultant.

2. By qualified Technicians of each Flooring Installer for which testing is required.

D. Flooring Installer Responsibility: For each Project flooring product for which testing is required, submit following written documentations from Flooring Manufacturer prior to conducting testing and final floor treatments.

1. Approval of specified testing method and testing criteria for each specific affected Project product.

2. Approval of specified floor treatment materials and methods for each specific affected Project flooring product.

E. Floor Treatment Installer Qualifications: Submit documentation for following, if floor treatments required for Project.

1. Installation Experience:

   a. Ten (10) years experience installing MVT and pH resistant coatings of similar types on Projects of similar scope, installation complexity.

   b. Four (4) current installations using specific Project products on Projects of similar scope and installation
complexity. Describe project scope, square feet of each installed product, installation complexity and include at least one MVT and one pH challenged project.

2. Floor Treatment Manufacturer Certification: Submit Manufacturer’s certification approving selected Installer as having requisite knowledge and experience to properly install each Project product.

F. Substrate Conditions - Restriction: Do not install MVT and pH sensitive flooring materials over substrates with moisture content or alkalinity, or both, that are not within acceptable criteria that is allowed by any Project scheduled Flooring Manufacturer.

G. Testing:

1. Exception to Test Criteria: Performance requirements may be altered when Manufacturer of scheduled flooring over any substrate accepts following conditions in writing.
   a. Submits alternate performance criteria that is warranted as acceptable to Flooring Manufacturer for each specific product for which an alternate criteria is allowed.
   b. Submits detailed test procedures and test equipment data to be used when different than specified testing.
   c. For any alternate testing procedure, submits scientific justifications why alternate testing results in reliable data for which Manufacturer can warrant for specific Project conditions under which It’s product is to be installed.

2. Test Reports: Submit detailed submittals of following for each flooring for which testing is required.
   a. Reports: Show not less than following for each test.
      1) Location designation, by number or other logical designation; as correlated on plan drawing.
      2) Each test type conducted, e.g. MVT or pH.
      3) Date and time each test conducted.
      4) Results of each test conducted.
      5) Specific test method used, e.g. ASTM or other.
      6) Temperature and humidity readings at area where each test conducted.
b. Plan Drawing: Show location of each test correlated with report test data.

c. Remediation Reports: If corrective measures required, for each type of corrective measure instituted, maintain detailed historical record, by day and location, of corrective measure instituted and results attained.

1.05 WARRANTY:

A. Manufacturer’s Warranty: Submit Manufacturer’s written and executed “Materials and Installation Defects Warranty” covering adhesion, moisture reduction, and alkalinity associated defects occurring in applied coatings for Period of ten (10) years from date certified by the Architect for Substantial Installation of Project.

PART 2 - PRODUCTS

2.01 FLOOR TREATMENT SYSTEMS – GENERAL CHARACTERISTICS:

A. Capable of reducing unacceptable moisture vapor transmission or pH, or both, to levels acceptable to Manufacturer’s of each flooring product scheduled to be applied over any tested substrates.

B. Approved by each Manufacturer of Project flooring products to be installed over any Project MVT or pH resistant, or both, coating products.

C. Capable of staying fully bonded to substrate under installed conditions, up to maximum published performance limits; for life of product.

D. Does not cause concrete to lose alkalinity beyond point where it becomes detrimental to concrete structure, e.g. becomes more acid and therefore accelerates deterioration of concrete.

2.02 MOISTURE VAPOR TRANSMISSION (MVT) FLOOR TREATMENT SYSTEM:

A. MVT-1:

1. Product: Ardex “Ardex MC Plus” system or comparable product approved by the affected Product Manufacturer and acceptable to the Architect.

2. Primary Characteristics:

a. Type: Water based, two coat, 100% solids epoxy coating system.

b. Performance: Capable of reducing moisture vapor transmission of 98% RH maximum or 20 lbs/1000 sf maximum to levels specified or as otherwise approved by
the affected Product Manufacturer and acceptable to the Architect.

B. MVT-2:

1. Product: Ardex “Ardex MC Ultra” system or comparable product approved by the affected Product Manufacturer and acceptable to the Architect.

2. Primary Characteristics:
   a. Type: Water based, two coat, 100% solids epoxy coating system.
   b. Performance: Capable of reducing moisture vapor transmission of 98% RH maximum or 20 lbs/1000 sf maximum to levels specified or as otherwise approved by the affected Product Manufacturer and acceptable to the Architect.

2.03 ALKALINITY (pH) FLOOR TREATMENT SYSTEM:

A. pH-1:

1. Products: One of following.
   a. Either MVT-1 or MVT-2 when pH only needs to be reduced to Contract limits.
   b. When MVT and pH both needs to be reduced, specifically select MVT-1 or MVT-2 capable of reducing both to required Contract limits.

2. Primary Characteristics: Capable of reducing concrete surface pH to 9 minimum when tested alkalinity is as high as 14.

PART 3 - EXECUTION

3.01 PREPARATION FOR TESTING:

A. Environmental Conditions:

1. General: Each area in which tests are to be performed are to be acclimated to ambient temperature and relative humidity levels that would occur under actual occupancy and use and is to be maintained for full duration of Contract Period once established.

2. Elevated Floors: For elevated floors, acclimation to include in-service temperature and humidity conditions above and below such affected floor structures.
3. Establishment of Temperature and Humidity Equilibrium:
   a. Requirement: Where environmental conditions are unlike in-service conditions, establish in-service conditions, e.g., HVAC is turned on, for period of 48 hours minimum or until floor substrate has stabilized to in-service conditions.
   b. Monitoring: Just prior to establishment of in-service conditions, take moisture meter readings of floor substrate. Monitor moisture levels continuously until there is no more change in readings. Location of each reading to be at same as locations determined for MVT and pH testing locations.

B. Equipment Acclimation: When required by specified test methods, acclimate equipment, e.g., probes, as required for each test method.

C. Substrate Preparation: Remove all deleterious products from surfaces that could contaminate testing results, including preparation materials. Remove deleterious materials from surface without destroying surface.

3.02 TESTING – GENERAL:

A. General: Test each substrate to verify that moisture vapor transmission and alkalinity levels are within each Flooring Manufacturer’s published requirements for each Project product, after substrate preparation and just prior to installation of flooring assembly materials.

B. Scope of Tests: Unless a greater amount of testing required by the Manufacturer of any affect product, comply with not less than the following.

1. New Work: Three tests for first 1000 sf and one additional test per 1000 sf of area thereafter. First 1000 sf to be at location to be acceptable to the Architect and be at a location where moisture would be most likely the highest.

2. Existing Work: A reduced scope and frequency may be used when acceptable to the Architect. Frequency to be increased to that for “new work”, if MVT exceeds levels required for any flooring.

3. Scope Change: Scope of testing may be changed when acceptable to the Architect and when it can be shown that current applicable standards and affected Flooring Manufacturer is willing to accept in writing a change in the testing scope.

C. Timing of Testing: Perform MVT and pH testing at same time at each selected test location and adjacent to each other. Ensure testing locations do not contaminate each other.
3.03 MOISTURE VAPOR TRANSMISSION TESTING:

A. Standards: Testing not to be in conflict with any of following, unless otherwise acceptable to the Architect.


B. Acceptable Test Methods: One or both of following as required and approved for use by each Manufacturer of flooring products to be applied over substrates to be tested.

1. Calcium Chloride Test: ASTM F 1869 “Anhydrous Calcium Chloride Quantitative Test Unit Method”.


3.04 ALKALINITY (pH) TESTING:

A. Standards:

1. ASTM D 4262, “Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces”.


B. Test Equipment: Litmus paper kit designed for testing pH levels on concrete. Litmus paper to be capable of measure pH levels from 0 to 14.

C. Number of Tests: Same as required for MVT testing.

D. Test Method:

1. Each Test Area: Approximately 1" diameter.

2. Substrate Preparation: Abrade test location to 1/32" minimum depth but not exceeding 1/8"

3. Water: Apply de-ionized and distilled water to abraded area. Allow to stand for 60 seconds.

4. Litmus Strip: Dip into puddle and remove immediately. Compare with pH charts to determine pH.
3.05 INSTALLATION MVT & pH FLOOR TREATMENTS:

A. General: Where MVT and pH not within acceptable levels, install MVT and pH coatings in strict accordance with each Manufacturer’s Project specific requirements as needed to reduce water vapor emission rates or pH, or both, to levels acceptable to each Flooring Manufacturer’s requirements specific to each product scheduled to be applied over tested substrates; as fully submitted and successfully reviewed by the Architect and at no additional cost to the Owner.

3.06 FIELD QUALITY CONTROL:

A. Retesting:

1. General: After fully curing MVT and pH coatings, retest substrates in accordance with MVT and pH Coating Manufacturer’s requirements to assure that MVT and pH are within acceptable levels for installation of each Project product scheduled over each tested substrate.

2. Test Locations: Retest all same locations as original MVT and pH testing occurred.

B. Submittals: Submit following.

1. Test reports.

2. Final approvals from each Flooring Installer and Flooring Manufacturer of test results.

3.07 PROTECTION:

A. Protections:

1. Where MVT and pH coatings required, coordinate installation of coatings to protect it from contamination, damage and deterioration prior to time when subsequent scheduled finishes can be applied.

2. Provide protections from Contractor’s ongoing operations during interim prior to time when final scheduled finishes are applied.

3. Submit to Contractor written methods necessary to protect coatings from contamination, damage and deterioration.

4. Submit to each Installer scheduled to apply subsequent materials to MVT and pH resistant coatings, methods and restrictions required to assure proper performance of membrane and bonding of final finishes to coatings.

END OF SECTION
SECTION 09650 – RESILIENT FLOORING

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Resilient sheet flooring.
      2. Resilient wall base.
      3. Accessories.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 1 – Unit Prices.
      3. Division 3 – Cast-In-Place Concrete.
      4. Division 3 – Concrete Repair.
      5. Division 9 – Flooring Treatment.

1.03 SUBMITTALS:
   A. Product Data: Submit technical data for each resilient material and accessory.
   B. Shop Drawings: For each installation area, submit layout of sheet flooring materials; showing joint pattern in sheets.
   C. Samples: Submit following.
      1. Resilient Flooring: Full size samples, but not less than 8-1/2" x 11" in size.
      2. Accessories: Profile x 11" lengths.
   D. Quality Assurance Submittals: Refer to “Quality Assurance” paragraphs herein.
   E. Closeout Submittals: Refer to "Maintenance" paragraphs herein.
1.04 QUALITY ASSURANCE:

A. Installer Qualifications:

1. Installation Experience: Eight (8) years, continuous and current, resilient flooring experience with not less than three (3) successful current linoleum projects on project of similar scope and installation complexity.

2. Manufacturer Approvals: Submit written documentation of the following.

   a. Installer Approval: Each RF Manufacturer’s written certification as an approved Manufacturer Installer, secured not less than two (2) years prior to time Project first Bid.

   b. Materials: For each Project product submit each RF Manufacturer’s written list of approved related materials, including those required for final cleaning and finishing, required for each Project specific installation condition and substrate.

1.05 WARRANTY:

A. RF Manufacturer’s Warranty: Where any of following RF-# types are scheduled for the Project, submit Resilient Flooring Manufacturer’s written and executed standard “Manufacturing Defects Warranty”, covering manufacturing defects for following periods from date of Project acceptance by the Architect

   1. Resilient Flooring: Five (5) years.

   2. Wall Base: Two (2) years.

1.06 MAINTENANCE:

A. Maintenance Instructions: Submit each RF-# Product Manufacturer’s maintenance instructions.

B. Extra Materials: Furnish not less than following or 2% of each; whichever is greater to the Owner.

   1. 200 sf minimum of each resilient flooring product.

   2. Five rolls of wall base of each type, size and color.

PART 2 - PRODUCTS

2.01 RESILIENT FLOORING:

A. Products:

   1. Basis of Design: As scheduled.
2. Preapproved equals acceptable to the University.

B. **Form:** Sheet.

C. **Standard:** ASTM F 1913 (Without Backing).

D. **Gage:** 0.080" minimum.

E. **Appearance Characteristics:** As scheduled for color, pattern, texture and finish as may be applicable to each product. Where not scheduled, verify from the Architect; otherwise make available full range of available characteristics for each product line that are not scheduled for selection by the Architect.

F. **Tested Performances:**
   1. **Static Load Limit:** ASTM F 970 as typical for each scheduled product.
   2. **Fire:**
      a. **Critical Radiant Flux:** ASTM E 648 or NFPA 253, Class I.
      b. **Smoke Developed:** ASTM E 662 or NFPA 258, 450 or less.
   3. **Anti-microbial Treatment:** ASTM G 21, passes.
   4. **Chemical Resistance:** ASTM F 925, no change for all chemicals.
   5. **Organic Emissions:** ASTM D 5116 tested and meeting State of California 01350 requirements.

2.02 **WALL BASE:**

A. **General Characteristics:** Comply with following, unless otherwise acceptable to the Architect.

1. **Type:**
   a. **Rubber:** ASTM F 1861, Type TS (Thermoset rubber), Group 1(solid).

2. **Height:** As scheduled, but not less than 4".

3. **Lengths:** Roll stock in longest available lengths; as required to install least amount of seams in any run.

4. **Thickness:** 1/8" gage.

5. **Style:**
   a. **Typical:** Cove (with toe).
   b. Matching end stops and preformed corner units.
6. **Finish**: Matte, unless otherwise scheduled.

7. **Colors**: As scheduled.

B. **Product**:

1. **Basis of Design**: As scheduled.

2. **Acceptable Manufacturers**: Subject to compliance with requirements, one of following when acceptable to the Architect.
   
   a. Burke Mercer Flooring Products.
   
   b. Roppe Corporation.

2.03 **ACCESSORIES**:

A. **Acceptable Manufacturers**: Products from one of the following.

1. Burke Mercer Flooring Products.

2. Johnsonite, Division of Tarkett.

3. Roppe Corporation.

B. **Resilient Edge Strips**: 1/8" thick, 1" width minimum, homogeneous rubber composition, tapered or bullnose profile, color to match adjacent flooring, and with provision for adhesive application.

2.04 **MISCELLANEOUS MATERIALS**:

A. **General**: For each Project required product, miscellaneous materials are to be specifically approved by the Resilient Material Manufacturer of each product for the Project specific conditions of use and installation.

B. **Leveling and Patching Products**: Following when approved by the Product Manufacturer.

1. Products in Division 3 - Concrete Repair Section.

2. Other water insensitive cementitious-resin materials.

C. **Water Vapor Transmission Membrane**: Refer to Division 9 – Flooring Treatment Section.

D. **Primers**:

1. **Concrete Slab Primer**: Primer that is nonstaining to resilient product.

2. **MVT Membrane Primer**: If required by the Manufacturer when MVT membrane is required.
E. **Adhesives:** Required adhesives, e.g., acrylic, polyurethane, or epoxy; best suited for each Project installation and substrate condition and complying with SCAQMD 1168 VOC criteria. Types for slabs on grade to be waterproof and alkalai-resistant adhesives.

F. **Weld Rods:** Engineered by the Manufacturer for each product type, e.g., vinyl, rubber and linoleum. Provide full range of colors available for selection by the Architect. Include Manufacturers recommendations for best color matches for each product.

G. **Finishing Materials:** Cleaner, sealer and polish materials for added protection and published by Manufacturer for each primary resilient product or other products approved by the Manufacturer for each specific Project product.

**PART 3 - EXECUTION**

3.01 **PREPARATION:**

A. **General:** ASTM F 710.

B. **Moisture Vapor Transmission (MVT) and Alkalinity (pH) Testing:** For work bonded to concrete slabs, comply with following.

   1. Conduct testing in conformance with Division 9 – Floor Treatment Section.

   2. If testing indicates unacceptable levels of MVT and pH, install each Resilient Manufacturer’s approved MVT or pH coatings conforming to Division 9 – Floor Treatments Section, capable of reducing MVT or pH, or both, to acceptable levels.

C. **Deleterious Substances:** Remove from substrates that would prevent proper bonding of materials.

D. **Leveling and Patching:** Fill and patch minor defects in the substrates.

E. **Priming:** Prime surfaces when recommended by the Resilient Material Manufacturer to assure bonding of the resilient materials.

F. **Conditioning:** Condition resilient materials to each space prior to installation.

3.02 **INSTALLATION:**

A. **Resilient Flooring:**

   1. **Layout – General:** Layout each resilient flooring aligned parallel or at other angles with principal walls; as successfully reviewed by the Architect in Shop Drawing submittals
2. **Layout - Sheet Flooring:** Roll out and relax materials in each area. Lay out to minimize seams in each area. Locate seams away from primary traffic areas. Cross seams are not allowed; unless no other layout possible.

3. **Color, Pattern, Texture:** Match flooring in each area for color, pattern, and texture. Use from same sequence as manufactured and packaged. Where product has directional pattern/texture, lay grain running in one direction as directed by the Architect.

4. **Fitting:** Scribe, cut, and tightly fit resilient flooring to adjacent construction.

5. **Coverage:** Extend over entire floor in each area. Extend into adjacent closets, if any.

6. **Application:** Fully bond materials to the substrate in accordance with each Resilient Product Manufacturer’s requirements; without open cracks, voids, raising and puckering at joints, telegraphing of conditions below, or other surface imperfections. Hand roll flooring with properly weighted equipment to assure adhesion to each substrate.

7. **Base:** Construct integral flash cove wall base in accordance with the Manufacturer’s instructions. Provide cove support at transition from horizontal to vertical and standard cap trim.

8. **Reference Markers:** Accurately transfer to the finished resilient work any existing marks on the substrate which locate future work by others and which would otherwise be hidden by the installed resilient installation. Mark with removable, nonpermanent marking devices which clearly indicate the transferred mark.

B. **Resilient Flooring – Weld Rods:** Unless otherwise indicated, provide for all flooring products.

C. **Wall Base:** Apply to vertical substrates in each indicated area, including walls, columns, pilasters, casework, and other permanent construction. Install in lengths as long as practicable, with preformed units at corners. Tightly bond base to substrate throughout length of each piece. On irregular surfaces, fill voids along top edge of resilient wall base with Wall Base Manufacturer’s recommended color matched filler material.

D. **Resilient Edge Strips:** Provide wherever resilient flooring terminates and would otherwise have an exposed edge. Butt tightly and adhere securely to base floor substrate.

3.03 **DEFECTS, DAMAGES, CLEANING & PROTECTION:**

A. **General:** Comply with Division 1 requirements.
B. **Finishing:**

1. **General:** Finish all products in accordance with each Product Manufacturer's maintenance data using each Product Manufacturer's recommended products.

2. **RF-# Specific Finishing:** Provide following for each product.
   
   a. **Cleaner:** Perform initial cleaning.
   
   b. **Sealer:** If a sealer is indicated in Manufacturer published requirements, apply sealer after cleaning.
   
   c. **Polish:** Apply 3 - 5 coats as required by each Product Manufacturer.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Specialty chemical resistant floor coating system.
   B. Related Sections:
      1. Division 1 – Sections, general.
      2. Division 1 – Unit Prices.
      3. Division 3 – Concrete Repair.
      4. Division 4 – Concrete Masonry Units.
      5. Division 9 – Gypsum Board.
      6. Division 9 – Flooring Treatment.
      7. Division 11 – Laboratory Equipment.
      8. Division 12 – Specialty Casework.

1.03 DEFINITIONS:
   A. Anti-Microbial Resistance: As used herein, the definition is restricted to the tested fungus resistance of coating formulations and in particular to its resistance to what is commonly known as "toxic molds" that produce mycotoxins. Bacteria and virus resistance is not necessarily included, unless specifically specified or is an additional resistance that is inherent in the anti-microbial additives in the coating formulations for this Project.

1.04 SUBMITTALS:
   A. Product Data:
      1. General: For each coating system, submit complete data on all coatings and related materials required, including but not limited to, general published system data, technical data sheets showing tested performances, Project specific installation instructions, e.g. preparation, application and clean-up, and maintenance data.
2. **Color and Pattern Charts**: Submit full range of available colors and patterns for initial selection by the University.

B. **Shop Drawings**: Submit Shop Drawings showing Project specific plans, sections and details of each installation.

C. **Samples**:
   1. **Typical Format**: Submit 8-1/2" x 11" samples of each complete coating system and each color and texture required. Reveal 1" strips of each underlying material layer across 8-1/2" width of each sample. Apply samples to 1/2" minimum thickness plywood substrate.
   2. **Texture Samples**: In addition to samples of each standard finish texture. Provide samples of a range of more slip resistant profile textures for review by the University. University to select from full range of possible textures as provided on samples.

D. **Quality Assurance Submittals**: Submit documentation as specified in "Quality Assurance" paragraphs herein.

E. **Closeout Submittals**: Submit documentation as specified in "Maintenance" and "Warranty" paragraphs herein.

1.05 **QUALITY ASSURANCE**:

A. **Manufacturer's Qualifications**: Submit written documentation of the following.
   1. **Manufacturing Experience**: Ten (10) years minimum, continuous and current, experience manufacturing product coating systems of each type required for the Project on projects of similar scope and installation complexity.
   2. **Installer Approval**: Approve Installer as having the requisite experience and capability to properly install each Project system in strict accordance with the Manufacturer's Project specific requirements.

B. **Installer Qualifications**: Submit written documentation of the following.
   1. **Installation Experience**: Eight (8) years minimum, continuous and current, experience, successfully installing specialty coating systems of the Manufacturer or comparable systems of other Manufacturers on projects of similar scope and installation complexity. For each type of project system required, submit list of not less than five (5) successful projects of each system type, their location, square feet installed, and contact information.
   2. **Supervisor**: Assign full time Supervisor with each System Manufacturer's requisite installation experience and knowledge of
each type of Project specific coating system required. Supervisor to have five (5) years minimum, specific experience successfully installing specialized systems of types required for this Project. For each coating system, submit Supervisor's successfully installed Manufacturer's systems or comparable systems acceptable to the University.

3. Personnel: Assign personnel that have the requisite training and experience in installing each system type required for the Project. Submit list of each Project assigned personnel. Where personnel is not competent in all procedures, list specific procedures which each personnel is competent to execute. Each personnel to sign the list indicating their competence to execute procedures that has been listed under each of their names. Do not use any personnel for which they are not competent to install. No personnel is to be used on the Project that has not been qualified in this manner.

4. Project Documentation: For each work day in which any coating systems are installed, keep a record specific to each installation as follows.

   a. Installation for which each report is referencing.
   b. Project name, date and work period.
   c. Ambient temperature and humidity at start, middle and end of each installation period.
   d. Substrate temperature and moisture content at start, middle and end of each installation period.
   e. Project assigned personnel at each installation area.
   f. Notes on other conditions that could affect the installation quality, if any.

1.06 WARRANTY:

   A. Installer Warranty: Submit written and executed Installer's "Installation Defects" Warranty for period of two (2) years from date established by the University for Substantial Completion of the Project.

1.07 MAINTENANCE:

   A. Maintenance Instructions: Submit Manufacturer's maintenance instructions specific to each installed coating system.

PART 2 - PRODUCTS
2.01 MANUFACTURERS:

A. **Basis of Design:** The specified product of the Manufacturer herein is the basis for this Project.

B. **Acceptable Manufacturer:** Subject to compliance with the requirements, comparable product of the following may be incorporated when acceptable to the University.

1. Dur-A-Flex, Inc.

2. Preapproved equal product system acceptable to the University.

2.02 SEAMLESS EPOXY-QUARTZ FLOORING SYSTEM:

A. **System Type:** Chemical resistant, quartz aggregate, cementitious, epoxy floor coating system.

B. **Product - Basis of Design:**

1. **Manufacturer:** Crawford Laboratories, Inc. "Florock" line of products as specified hereunder.

2. **Primer:** "FloroCrete PT" or "FloroCrete HD".

3. **Matrix Coat:** "FloroCrete RT".

4. **Quartz Aggregate:** "BC Grade Colored Quartz" in color blend meeting following requirements.
   a. Match an existing adjacent installation when scheduled.
   b. In custom color blend to be selected by the University where not indicated to match an existing installation.

5. **Base Sealer Coats:** "Floropoxy 4805".

6. **Top Sealer Coat:** "Florock CR 250", clear.

C. **Related Materials:**

1. **Anti-Microbial Additive:** For each coating, Manufacturer's standard anti-microbial additive meeting the specified performance herein.

2. **Patching Material:** Florock line, "Floropoxy 4700" and "FloroCrete HD" or other System Manufacturer approved patching products.

3. **Joint Treatment:** Florock line, "System 6500 Elastomer" or other System Manufacturer approved comparable joint treatment product.
D. System Properties:
   1. **Coefficient of Friction**: ASTM D 1894, 0.80 minimum or ASTM C 1028, 0.60 minimum (wet and dry tested).
   2. **Service Temperature**: 235° F minimum.
   3. **Food Contact Performance**: USDA compliance for "Incidental Food Contact".

E. Matrix Coat Properties:
   1. **Coating Type**: Polyurethane modified, portland cement and filler based mortar.
   2. **Compressive Strength**: ASTM C 579, 9000 psi minimum.
   3. **Tensile Strength**: ASTM C 638, 2500 psi minimum.
   4. **Flexural Strength**: ASTM D 790, 5100 psi minimum.
   5. **Bond Strength**: 400 psi minimum.
   6. **Hardness**: ASTM D 2240, Durometer, Shore D of 85 minimum.
   7. **Abrasion Resistance (Taber)**: ASTM D 4060, 0.07 mg loss maximum, using CS17 wheel, at 1kg, at 1000 cycles.
   8. **Impact Resistance**: MIL-D-3134, pass.
   9. **Water Absorption**: ASTM C 413, 0.1% maximum.
   10. **Anti-Microbial Resistance**: ASTM G 21, passes.
   11. **VOC**: EPA Method 24, 0 gpl.

F. Base Sealer Coat Properties:
   1. **Coating Type**: Clear, 100% solids, self-leveling, epoxy coating.
   2. **Compressive Strength**: ASTM C 579, 11,200 psi minimum.
   3. **Tensile Strength**: ASTM C 638, 7300 psi minimum.
   4. **Flexural Strength**: ASTM D 790, 7770 psi minimum.
   5. **Bond Strength**: 400 psi minimum.
   6. **Hardness**: ASTM D 2240, Durometer, Shore D of 80 minimum.
   7. **Abrasion Resistance (Taber)**: ASTM D 4060, 105 mg loss maximum, using CS17 wheel, at 1 kg, at 1000 cycles.
G. **Top Sealer Coat Properties:**

1. **Coating Type:** Urethane, clear.
2. **Tensile Strength:** ASTM D 2370, 5500 psi minimum.
3. **Hardness:** ASTM D 2134, Sward Rocker of 65 minimum.
4. **Abrasion Resistance (Taber):** ASTM D 4060, 55 mg loss maximum, using CS17 wheel, at 1kg, at 1000 cycles.
5. **Flame Spread:** ASTM E 84, Class A or I.
6. **Gloss Level:** ASTM D 523 tested and resulting in MPI gloss level 4, satin gloss of 20-35 units at 60º.
7. **Chemical Resistance:** ASTM D 1308 and ASTM D 3363 tested for chemical types as published by the specified Manufacturer or comparable results of another product preapproved by the University.
8. **Anti-Microbial Resistance:** FS-TT-P-19 (with ASTM D 3273 and ASTM D 3274), ASTM D 5590, ASTM D 3273, ASTM D 2574, or ASTM D 3274 for toxic mold resistance.

2.03 **RELATED MATERIALS:**

A. **Flooring Treatment:** Comply with Division 9 – Flooring Treatment Section and Division 1 – Unit Prices Sections, if a MVT membrane is required.

**PART 3 - EXECUTION**

3.01 **EXECUTION - GENERAL:**

A. **Manufacturer's Requirements:** Comply in strict accordance with System Manufacturer's Project specific requirements as applicable to the system and substrate type and condition as fully submitted and successfully reviewed by the University.

B. **Continuity:** Ensure coatings are continuous and monolithic and are applied at the required thickness, including at coating transitions like inside and outside corners.

C. **Terminations:** Ensure terminations that exposed to view have well defined boundaries and are straight across lines of each boundary.

3.02 **EXAMINATION:**

A. **Tolerances:** Ensure floor tolerances are in accordance with System Manufacturer's requirements. Ensure defects, if any, e.g. high areas, low
areas, levelness and unsatisfactory slope tolerances, are corrected before start of any work.

B. **Moisture Vapor Transmission Testing:** Comply with Division 9 – Flooring Treatment Section. Provide a MVT membrane, if testing shows an MVT membrane is required. Coordinate the installation of the MVT membrane with other Project specific substrate preparation requirements of the Flooring Manufacturer to ensure the proper bonding of each Project flooring product.

3.03 **PREPARATION:**

A. **Preparation of the Base Substrate - Bonding Profile:** Where concrete finish profile was not coordinated with Division 3 - Concrete Finishing Section Installer, mechanically abrade surface to provide an acceptable System Manufacturer's approved bonding profile. Remove any remaining bond inhibiting materials after the mechanical abrading procedure, e.g. dust, dirt, laitance, efflorescence, curing compounds, grease, oil and other stains caused by other materials.

B. **Patching:** Examine base concrete slab for other defects, e.g. spalls, pits, holes, and cracks. Patch defects level with each type of patching material as required by the System Manufacturer for each patching condition.

C. **Joint Treatments:** For functional joints, e.g. expansion joints, contraction joints and termination joints, apply joint treatment materials over each joints. Ensure each joint is fully completed before applying joint treatment materials.

3.04 **INSTALLATION:**

A. **System Assembly Summary:** From base substrate up, the following is required.

1. Primer coat, if required by System Manufacturer, for any Project slab conditions.

2. Matrix coat with embedded, broadcast, quartz aggregate.


4. Top sealer coat.

B. **Primer:** Apply primer to prepared base concrete slab at System Manufacturer's required application rate.

C. **Matrix Coat:** Apply to 3/16” minimum thickness. Ensure coating is level. Broadcast quartz aggregate into wet coat to refusal of each color blend as scheduled for each installation area. Install in progressive manner in accordance with System Manufacturer's requirements. After full cure,
remove unbonded aggregate and dust, until only bonded materials remain
and surface is dust free.

D. **Base Sealer Coats:** Apply two coatings of the self-leveling, clear, sealer
coat to fill in-between spaces of the aggregate quartz and further lock-in the
aggregate surface at the System Manufacturer's required application rate.

E. **Sealer Coat:** Apply the final, chemical resistant, clear sealer, top coating as
at the System Manufacturer's required application rate.

3.05 **DEFECTS, CLEANING & PROTECTIONS:**

A. **General:** Comply with Division 1 requirements.

B. **Defective Work:** Replace defective work, e.g. damaged and deteriorated
work, with Contract complying work.

C. **Protection and Cleaning:** Protect, maintain, clean and polish all work for
duration of Contract Period to ensure work is without damage and
deterioration at Final Project Acceptance by the University.

**END OF SECTION**
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Exterior painting.
   2. Interior painting.

B. Related Sections:
   1. Division 1 Sections, general.
   2. Division 1 – Additive Bid Items.
   3. Sections covering substrates requiring painting.

1.03 DEFINITIONS:

A. Paint: A Paint Manufacturer’s system of related paint coating materials which are recommended for specific substrates and conditions of installation and when in accordance with the Manufacturer’s requirements achieves a composite coating of specific color, sheen, and texture which has characteristics consistent with the Paint Manufacturer’s tested performances of the system.

B. Unpainted: Surfaces over which new coatings are required, this includes those surfaces which have no previous paint coatings, surfaces which have primer paint coatings which have been applied by someone other than the Paint Installer, and surfaces which have an existing paint coating over which additional new coats are required.

C. Exposure Definitions: Refer to Division 1 - References Section for definitions.

D. Temporary Surfaces & Permanent Surfaces: For this Project exclusively, temporary surfaces refer to those surfaces that are anticipated to be removed or demolished completely as a result of the construction. Permanent surfaces are those that are to be left in place; even as a result of the construction. Where any surface may be temporary or permanent, consider this surface as a permanent surface; unless otherwise acceptable to Architect.
E. **Impact Substrates:** Surfaces exposed to the human hand, moving body/foot contact, mechanical abrasion, or other similar wearing or impact actions. Such surfaces include, but are not necessarily limited to, hand/guardrails, walking surfaces, metal doors and frames, coiling doors and frames, ladders, roof hatches, and metal corner guards or other protective metal at service areas.

F. **Nonimpact Substrates:** Those surfaces not defined as an impact substrate.

G. **Scheduled Colors:** Refer to “Quality Assurance” paragraphs herein for “intent” of scheduled paint colors.

1.04 **SUBMITTALS:**

A. **Product Data:** Submit, including MSDS data sheets.

B. **Samples:** Submit 8-1/2” x 11” brushout Project representative samples of each Architect selected color for review by Architect.

C. **Quality Assurance Submittals:** Refer to “Quality Assurance” paragraphs herein.

1.05 **QUALITY ASSURANCE:**

A. **Standard:** Comply with Master Painters Institute “Architectural Painting & Specifications Manual”; current edition; for all work.

B. **Specified Requirements and Other Treatments:** Surface preparation, priming, and coats of paint specified are in addition to shop-priming and surface treatments specified under other sections of work and in addition to any existing surface coatings.

C. **Paint Compatibility:** Verify compatibility of scheduled systems with prime coats or other finishes provided on work by other Installers (including those under separate prime contracts) and with existing paint coatings of previously painted substrates. Where any system is not compatible, provide appropriate barrier coats necessary to ensure bonding of paint coatings to the required substrate.

D. **Primer Certification:** For each substrate primed by other Installers, submit Paint Installer's certification that primers are compatible with paint systems to be provided for each primed substrate. Where primers are not compatible, indicate barrier/prime coats to be provided.

E. **Environmental Impact:** Where painting to take place under environmental and substrate conditions that do not fall within the recommendations in publications of Paint Manufacturer required to be submitted to Architect, submit additional data indicating methods approved by Manufacturer necessary to accomplish work under different conditions.
F. **Coordination:**

1. **Submittals of Other Installers:** Finish unfinished samples furnished by other Installers representing work that is to be painted by Installer of this Section.

2. **Finish Painting by Other Installers:** Coordinate matching of finishes required under other Sections with similar finishes to be provided under this Section.

3. **Removal/Reinstallation Work:** Coordinate requirements with Contractor and with other Installers to ensure that products not requiring painting are removed to extent necessary to assure proper painting of substrates on which products are installed. Removal work to occur prior to when painting work begins and with reinstallation of the removed work after completed coating systems have thoroughly cured.

G. **Mock-Ups:**

1. **Final Acceptance:** Final acceptance for each color, sheen, and texture will be from mock-ups provided, except as otherwise approved by the Architect. Do not purchase any paint materials, until final successful review is accomplished by Architect.

2. **Lighting Conditions:** For interior painting, simulate lighting conditions for review of each mock-up.

H. **Colors:** Any indicated Manufacturer’s paint colors is strictly for color intent and is not an approval of Paint Manufacturer for use on Project; unless specifically listed under Paint Schedules herein, unless otherwise acceptable to the Architect.

I. **Toxic Material Restrictions:** Refer to Division 1 – Product Requirements Section.

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**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. Acceptable Manufacturers: Subject to compliance with requirements, design is based upon products of scheduled Manufacturers. No other products are to be considered for Project.

2.02 **MATERIALS, GENERAL:**

A. **Paint Coatings:** As scheduled herein for type, sheen, and texture. Standard and custom colors to be selected by Architect.

B. **Mildewcide:** Where typical for locale, provide Paint Manufacturer’s
maximum recommended amount for each coating; without detriment to coating performance.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Removal of Installed Work: Remove door hardware, escutcheons, trim, plates, frames, and other similar items.

B. Protections: Construct and erect protections to prevent contamination and damage of substrates not required to be painted. Tape off adjacent surfaces for clean terminations of painting work at intersection with adjacent surfaces.

C. Substrate Preparation:

1. General: Perform in accordance with Paint Manufacturer's Project specific requirements. Do not use methods and materials that are destructive to substrate and existing finishes, but is capable of fully removing deleterious products from surfaces requiring painting. Apply effective barrier coatings, if required.

2. Existing Painted Substrates: Painted substrates part of original structures remaining after start of Project to comply with following.

   a. Exterior Surfaces: Power wash. Utilize methods to prevent flooding and damage. Fully dry surfaces before beginning painting work. Utilize other cleaning methods to remove contaminants not removed by power washing.

   b. Interior Surfaces: As required to clean surfaces of contaminants.

   c. Unsound Coatings: Remove to sound coatings or original substrate. Sand perimeter of where sound coatings terminate at area where unsound coatings removed. Apply primer and final coats in manner to assure base work does not telegraph through final coats.

3. Impact Metal Surfaces: Specified requirements are minimums and Installer is to verify level of cleanliness needed for each paint coating to ensure their performances under Project conditions.

3.02 PAINT MATERIALS PREPARATION:

A. Manufacturer’s Instructions: Mix and prepare painting materials in accordance with Paint Manufacturer’s instructions.
3.03 QUALITY ASSURANCE, CONDITIONS PRIOR TO APPLICATION:

A. **Environmental Conditions**: For each paint coating, comply with Paint Manufacturer’s Project specific requirements when painting is permitted to be accomplished; under following conditions.

1. Wet and humid conditions for air and substrate.
2. Air Temperatures.

B. **Substrate Conditions**:

1. **Curing Period**: As required to ensure performance of paint coatings.
2. **Alkaline Conditions**: Test alkalinity of substrates. Correct conditions where substrates are sufficiently alkaline to cause blistering and burning of coatings.
3. **Moisture Content**: Do not paint over surfaces where moisture content exceeds that permitted in Paint Manufacturer’s printed directions. Test surfaces with appropriate moisture meter. For wood, do not paint when moisture content exceeds ±3% above or below 12% moisture content. For plaster do not exceed 15% moisture content.

3.04 APPLICATION:

A. **Manufacturer’s Instructions**: Apply paint products in accordance with Paint Manufacturer’s directions. Alter formulations only in accordance with those directions.

B. **Coating Thickness and Number of Coats**:

1. **Intent**: Apply each required coat for each system at not less than Paint Manufacturer’s recommended spreading rates to establish the maximum Manufacturer specified WFT/DFT required. However, where undesirable subsurface or undercoating conditions show through the final coat of paint, which is the result of the paint coating materials or their method of application, apply additional coats until the paint film is of uniform finish, color, and appearance as acceptable to Architect; regardless of number of coats and whether or not such coatings comply with the Manufacturer’s WFT/DFT recommended.

2. **Minimum Number of Coats**: Not less than following.

   a. **New Substrates**:

      1) **Primer**: Single coat.
      2) **Finish Coatings**: Two coats.

   b. **Existing Painted Substrates**: Single finish coat over sound coatings.
C. **Color:** Where finish color coats are required, tint undercoats the same shade as final coat; with each undercoat slightly lighter in shade than the coat above.

D. **Backpainting and Priming of Moisture Sensitive Products:** Immediately upon arrival at job site of indicated products, accomplish following.

1. **Wood:**
   a. **Exterior:** Backpaint and prime unpainted, unprimed, or unsealed surfaces of wood products scheduled for finish paint coatings including, but not necessarily limited to, door frames, window frames, and standing and running trim. Apply one coating of first paint coat scheduled for surface.
   b. **Interior:** Backpaint any wood products in contact with concrete and masonry; part of exterior walls.

2. **Metals:** For unprimed ferrous and galvanized metal, apply primer scheduled for surface after proper substrate preparation. Prior to painting work, touch-up abraded or damaged shop primed work.

E. **Opaque Finishes:** Completely cover to provide an opaque finish that is uniform in color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, telegraphing, or other surface imperfections are not acceptable.

F. **Completed Work:** Match approved mock-ups for finish appearance, including for uniformity, opaqueness, color, sheen, texture, and coverage. Remove, refinish, or repaint noncomplying work to the specified requirements as acceptable to the Architect.

G. **Impact Substrate:** When painting is required for an impact substrate which is a part of a related unit of Work, provide same finish coatings for the related unit of Work. For instance, for a steel stair assembly where railings are a part of the work, for frames where steel doors are hung, etc.

### 3.05 PAINT SCHEDULE, GENERAL:

A. **Surfaces Requiring Painting:** Except where specifically not indicated to be painted, paint all previously existing painted substrates, all new exposed substrate surfaces of types for which paint systems are specified herein, and other substrates indicated on Contract Drawings.

B. **Surfaces Not Requiring Painting:** Except as otherwise indicated as follows.

1. Concealed surfaces.
2. Prepainted work of other Installers, except as otherwise indicated. Shop primed work not included.
3. Anodized aluminum, bronze, brass, copper, and stainless steel.
4. Natural stone and cast stone made to look like natural stone.

5. Ceramic tile.

6. Metal plated finishes.

7. Operating parts of equipment.

8. Identification labels and plates with product’s description, code required information, performance rating, nomenclature, model number, and similar information.

C. Semi-Exposed Surfaces: Except as otherwise indicated or acceptable to Architect, paint any semi-exposed surfaces where the exposed surfaces of the specific related work is required to be painted.

D. Galvanized and Ferrous Metal: Paint exposed and semi-exposed, unpainted or shop primed surfaces.

E. Mechanical/Electrical Work:

1. Division 15/16 Requirements: Refer to Sections in each Division for further requirements.

2. Components:

   a. Unpainted Work: Paint exposed unpainted surfaces of bare and covered conduit, pipes, ducts, hangers, related steel and iron work. Provide safety colors when required by Authorities and as otherwise indicated.

   b. Painted Work: Paint pre-painted mechanical grilles, diffusers, trim, and other similar finished components that are a different color or sheen than adjacent painted construction.

3. Equipment: Paint unpainted or primed, exposed, ferrous and galvanized metal surfaces of equipment, including mechanical ductwork, motor or other equipment housing, enclosures, cabinets, and supporting equipment.

4. Interior of Mechanical Ducts: Paint interior of ducts directly above supply and return air duct grilles with a flat, nonspecular, black paint.

F. Equipment/Furnishings: Paint surfaces behind moveable equipment and furnishings same as similar adjacent surfaces. Paint surfaces behind permanently fixed equipment and furnishings with prime coat only before final installation of equipment.

3.06 PAINT SCHEDULE, SHEENS:

A. General: Except as otherwise indicated, surfaces scheduled for opaque coatings are to comply with requirements hereunder.
B. **Typical**: Except for “Exceptions” paragraphs, as follows.

1. **Non-Metal**: Eggshell.
2. **Metal**: Semi-gloss, except gloss when specified.

C. **Exceptions**:

1. **Metals, Exterior and Interior - Impact**: Gloss as indicated under “Other Coatings” paragraphs; for impacted metals, e.g. doors of all types, door frames, handrails, ladders, corner guards, etc.

### 3.07 PAINT SCHEDULE, COATINGS - GENERAL:

A. **Acronyms**: Acronyms for listed Manufacturers are as follows.

1. **BM**: Benjamin Moore.
2. **CAR**: Carboline.
3. **GLD**: Glidden.
4. **SW**: Sherwin Williams.

B. **Definitions**: Comply with Division 1 - References Section for definitions of “exterior” and “interior” to determine whether substrates are exterior or interior.

C. **Manufacturer’s Products**: For each substrate, utilize primer and topcoats of only one Manufacturer.

D. **Coating Types for Each Substrate**: Provide applicable primer over prepared substrate and follow with finish coatings of scheduled sheen type as specified herein; as applicable to exterior or interior exposure. Number of coats as specified in other paragraphs herein.

### 3.08 EXTERIOR PAINT SCHEDULE - STANDARD COATINGS:

A. **General**: Not required.

### 3.09 INTERIOR PAINT SCHEDULE - STANDARD LOW VOC COATINGS:

A. **Schedule**: For substrates where “Interior Paint Schedule – Specialty Coatings” is not scheduled, e.g., Main Entry, Loading Entry and Storage.

B. **Primers**:

1. **Cementitious Non-Masonry Materials - Concrete**:
   a. **BM**: 528 Aura Waterborne Interior Semi-Gloss
   b. **GLD**: 3030 Concrete Coatings Bond Prep Bonding
c. SW: A24W8300 Loxon Acrylic Masonry Primer
d. Preapproved equal.

2. Concrete Masonry Units:
   a. BM: 160 Super Spec Latex Block Filler
   b. GLD: 4000 Bloxfil Block Filler
c. SW: B25W25 PrepRite Block Filler
d. Preapproved equal.

3. Gypsum Board:
   a. BM: 528 Aura Waterborne Interior Semi-Gloss
   b. GLD: 1000 High Hide Wall Interior Primer-Sealer
c. SW: B11W900 S-W Harmony Low Odor Int Ltx Primer
d. Preapproved equal.

4. Metals – Ferrous:
   a. BM: P04 Super Spec HP Acrylic Metal Primer
   b. GLD: 4160 Devguard Multi-Purpose Tank & Struct
c. SW: B66-310 S-W ProCryl Universal Primer
d. Preapproved equal.

5. Metals – Galvanized:
   a. BM: Not Req When Substrate Properly Prepared
   b. GLD: 4020 Devflex DTM Primer & Flat Finish
c. SW: B66-310 S-W ProCryl Universal Primer
d. Preapproved equal.

B. Finish Coatings:

1. Eggshell:
   a. BM: 524 Aura Waterborne Interior Eggshell
   b. GLD: 1403V Diamond 350 Interior Eggshell
c. SW: A97-1200 Duration Home Interior Latex Satin
d. Preapproved equal.

2. Semi-Gloss:
   a. BM: 528 Aura Waterborne Interior Semi-Gloss
   b. GLD: 1407V Diamond 350 Interior Semi-Gloss
   c. SW: A98-1200 Duration Home Interior Latex Semi-Gloss
   d. Preapproved equal.

3.10 EXTERIOR PAINT SCHEDULE – SPECIALTY COATINGS:

A. Exterior Steel:
   1. System Type: Zinc- Polyurethane-Fluoropolyurethane.
   2. Preparation:
      b. Galvanized: SSPC-SP1 or SSPC-SP7, or both.
   3. Primer: Not required for undamaged galvanized work.
      a. TN: 90-97 Tneme-Zinc Series at 3 - 5 mils DFT
      b. CAR: 859 Organic Zinc at 3 - 5 mils DFT
      c. Preapproved equal.
   4. Intermediate Coating:
      a. TN: N69 Hi-Build Epoxoline at 3 - 5 mils DFT
      b. CAR: 133HB Aliphatic Urethane at 3 - 5 mils DFT
      c. Preapproved equal.
   5. Intermediate Coating:
      a. TN: Series 73 Endura-Shield at 2 - 3 mils DFT
      b. CAR: 950 Gloss Carboxane at 2 - 3 mils DFT
      c. Preapproved equal.
   6. Finish Coating:
      a. TN: 1070 Fluoronar at 2 - 3 mils DFT each coat
      b. CAR: 950 Clear Carboxane at 2 - 3 mils DFT
3.11 INTERIOR PAINT SCHEDULE – SPECIALTY COATINGS:

A. Schedule: For all interior surfaces, except where “Interior Paint Schedule – Standard Low VOC Coatings” are indicated.

B. System Type: Catalyzed Polyamine Epoxy, Zero VOC.

1. **Concrete and CMU:**
   a. SW: B42W46 Heavy Duty Block Filler
   b. Preapproved equal.

2. **Gypsum Board:**
   a. SW: B30-2600 Series ProMar 200 Zeor VOC
   b. Preapproved equal.

3. **Metals – Ferrous and Galvanized Steel:**
   a. SW: B66-310 Series ProIndustrial Pro-Cryl Univ Primer
   b. Preapproved equal.

C. **Finish Coatings:**

1. **Eggshell:**
   a. SW: B73-360 Series ProIndustrial Wtrbrn Cat Epoxy Egshl
   b. Preapproved equal.

2. **Semi-Gloss:**
   a. SW: B73-300 Series ProIndustrial Wtrbrn Cat Epoxy Gloss
   b. Preapproved equal.

END OF SECTION
SECTION 10220 – LOUVERED EQUIPMENT ENCLOSURES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Aluminum louvered equipment screens.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 5 – Shop-Applied Finishes for Metal.
      3. Division 5 – Steel Deck.
      4. Division 7 – Roof & Deck Insulation.
      5. Division 7 – Modified Bitumen Membrane Roofing.
      6. Division 7 – Flashing & Sheet Metal.
      7. Division 15 Mechanical Sections.

1.03 SYSTEM DESCRIPTION - PERFORMANCES:
   A. Structural Loads: In addition to other structural performances, engineer louvered equipment screen units for windload performances based IBC 2006 requirements for pressures based on 105 mph windload at grade, Exposure B, Importance Factor 1, with pressures adjusted for height and exposure of each louvered equipment screen unit component and with deflection limited to the Louvered Equipment Screen Manufacturer’s requirements, but not less than the following.
      1. Structural Members: L/180 or 0.75” whichever is less.
      2. Louver Blades: L/120 or 0.50” whichever is less.
   B. Design Intent – Structural Supports:
      1. General: Supports to be provided as part of the Contract with the Louvered Equipment Screen Manufacturer.
      2. Vertical Supports: Engineer structural performance of each louvered equipment screen assembly based on the structural support spacing as shown on the Drawings.
3. **Engineering Parameters:** Following may be provided when added features do affect the original design intent of the University’s Architect and original engineering of the University’s Structural Engineering Consultant.
   
   a. Larger or heavier supports, or both.

   b. Additional supports, e.g. bracing.

1.04 **SUBMITTALS:**

   A. **General:** Submit in accordance with Section 01300 - SUBMITTALS.

   B. **Product Data:** Submit material and installation specifications, tested performances and paint coatings color charts.

   C. **Shop Drawings:** Submit. Show plans, elevations, and details indicating materials, finishes, joinery, connections, anchorage, and other information to determine compliance with requirements. Show coordination with adjacent work, e.g. flashing and sheet metal and roofing work.

   D. **Samples:** For each paint type, color, and sheen submit 6” square project representative finished samples on same type, gage, and alloy of metal as actual products to be provided.

   E. **Quality Assurance Submittals:** Refer to "Quality Assurance" paragraphs herein.

   F. **Closeout Submittals:** Refer to "Warranty" paragraphs herein.

1.05 **QUALITY ASSURANCE:**

   A. **Manufacturer Qualifications:** Comply with Division 1 Requirements.

   B. **Engineering:**

      1. **Engineer:** Submit engineering data by a Manufacturer selected, licensed Engineer knowledgeable with engineering of Louvered Equipment Screen Manufacturer’s products that is required for this Project and capable of engineering products to comply with the Project Code and local Authority requirements.

      2. **University’s Review:** Review of engineering data does not validate engineering performances by University which remains responsibility of Louvered Equipment Screen Manufacturer.

1.06 **WARRANTY:**

   A. **Manufacturer’s Warranty - Fluoropolymer Paint Coatings:** Submit in accordance with Division 5 – Shop Applied Finishes for Metal Section.
PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. General: Subject to compliance with requirements, products from one of the following.

1. Architectural Louvers.
2. Industrial Louvers, Inc.
3. United Enertech.

2.02 MATERIALS:

A. Extrusions: ASTM B 211, Alloy 6063-T5, 6063-T6, 6061-T6 or other standard Manufacturer's structural alloy acceptable to the University.

B. Sheet: ASTM B 3209, Alloy 1100, 3003, 5005 or other standard Manufacturer's structural alloy acceptable to the University.

2.03 LOUVERED EQUIPMENT SCREEN UNITS:

A. LV-SCRN-1:

1. Product: One of following.
   a. Airolite “SCH Series”.
   b. Construction Specialties, Inc. "RS Series".
   c. Ruskin “EME Series”.
   d. Or pre-approved equal.

B. Basic Louvered Equipment Screen Type: Horizontal, inverted blade units.

C. Primary Louver Blade Characteristics: Unless otherwise indicated, louvered equipment screen units to comply with following.

1. Blade Depth: Louvers may be any standard depth from 2” minimum to 6” maximum depth that can be engineered for the Project windloads.

2. Cross Section Thickness:
   a. Louver Blades: 0.080” thick minimum.
   b. Other Components: 0.125” thick minimum.

4. **Paint Finish:** Fluoropolymer coating comply with Division 5 – Shop Applied Finishes for Metal Section. Color as scheduled; where not scheduled, verify from the University prior to Bid and include impacts in the Bid.

2.04 **RELATED MATERIALS:**

A. **Structural Support Assembly:** Comply with Division 5 – Metal Fabrications – General and Division 5 – Metal Fabrications – Steel Sections.

B. **Anchorage Devices:** Aluminum or 300 series stainless steel devices. Exposed devices to match finish/color of fastened components.

C. **Bituminous Paint:** SSPC-Paint 12.

D. **Joint Sealant:** Provide single component urethane of type required in Division 7 - Joint Sealers.

E. **Field Touchup Paint:** Provide matching field applicable fluoropolymer paint coatings in accordance with Division 5 – Shop Applied Finishes for Metal Section.

2.05 **FABRICATION:**

A. **General:** Comply with Louvered Equipment Screen Manufacturer's standard fabrication requirements for product type, except as necessary to comply with project specific requirements and conditions.

B. **Structural Provisions:** Provide for additional reinforcements when required for opening sizes and wind loading exposures.

C. **Expansion Provisions:** Provide for expansion and contraction in units as required by opening sizes and exposures.

D. **Finishes:** Apply fluorocarbon coating in strict compliance with Coating Manufacturer's requirements acceptable to Louvered Equipment Screen Manufacturer. Finished units to be free of scratches and blemishes.

PART 3 - EXECUTION

3.01 **INSTALLATION:**

A. **General:** Install each work in strict accordance with the Louvered Equipment Screen Manufacturer's Project specific requirements as fully submitted and successfully reviewed by the University. Locate and place louver units plumb, level and in proper alignment with adjacent work. Form tight joints with exposed connections accurately fitted together. Seal joints in conformance with Division 7 - Joint Sealers section requirements as applicable to work and with joint sealing materials to provide a weathertight installation.
B. **Erection Tolerances:**

1. **Variation from Plane:** 1/8" per 12'-0" length, but not exceeding total non-cumulative dimension of 1/2" out of plane.

2. **Offset from True Alignment:** Between components in any assembly the alignment to be accurate within 1/16".

C. **Anchorages:** Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

D. **Damages:** Repair damages, including finishes, caused by installation operations. Touch up minor damaged factory applied finish coatings with Louvered Equipment Screen Manufacturer’s matching paint. Restore all damages in manner so there is no evidence of corrective work or as otherwise acceptable to University. Replace unsatisfactory units with new units.

E. **Electrolytic Protection:** Apply a heavy concealed coating of bituminous paint to separate electrolytically sensitive surfaces including, but not necessarily limited to, aluminum from concrete, aluminum from treated wood, and all work from copper.

3.02 **DEFECTS, CLEANING & PROTECTIONS:**

A. **General:** Comply with Division 1 requirements.

**END OF SECTION**
SECTION 10260 – WALL & CORNER GUARDS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Resilient wall guards.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 9 – Metal Support Assemblies.
      3. Division 9 – Gypsum Board.

1.03 SUBMITTALS:
   A. Product Data: Submit each required product, each Manufacturer's technical literature describing the materials, performances, and installation requirements specific to the Project requirements. Include color charts for initial color selections by the University from available standards for each line.
   B. Shop Drawings: Submit Shop Drawings and schedules indicating location of units, sizes, anchorage and other data necessary for proper coordination with Project requirements. Show joint pattern in continuous work.
   C. Samples: Submit Profile x 11" length samples of each University selected color and texture.

1.04 QUALITY ASSURANCE:
   A. Manufacturer Experience: Refer to Division 1 requirements.
   B. Continuous Work: Where several units are required in continuous work, provide units of equal length along length of each installation in manner acceptable to the University.

PART 2 - PRODUCTS
2.01 RESILIENT WALL GUARDS:

A. Primary Characteristics:

1. Materials:
   a. Plastic Cover: PETG extrusion in shock absorbing, snap-on configuration with 0.078” minimum cross sectional thickness. Color and texture as scheduled for Basis of Design product or preapproved equal.
   b. Metal Retainer: ASTM B 221, 6063-T6 alloy, aluminum extrusion with 0.062” minimum cross sectional thickness, in standard mill finish.

2. Performance Characteristics:
   a. Impact: ASTM F 476, drywall cracked with cover serviceable.
   b. Abrasion: ASTM D 4060 (Taber Abrasion), 10,000 cycles minimum to full depletion of texture.
   c. Fire: ASTM E 84 (UL-723), Class A or I.
   e. Fungus: ASTM G 21, growth not supported.
   f. Chemical: ASTM D 543, 19 common chemicals tested with 70% no change in the product and 30% with minor appearance changes.
   g. Color Consistency: SAE J1545, Delta E of 1.0 maximum, using CIE Lab, CIE, CMC, LCh, Hunter Lab or other University acceptable color space scale system.

3. Color and Texture: As scheduled for each Basis of Design product or preapproved color and texture.

B. CR-1 Products:

2. InPro (IPC) Corporation “Infinity System, Model G2-1500i”.
3. Preapproved equal.

2.02 RELATED MATERIALS:

A. Accessories: Resilient Guard Manufacturer’s end caps, returns, continuous cushion bumpers, and other accessories available with each required
product. Exposed accessories to match color and finish of primary resilient cover.

B. **Anchorage Devices:** Stainless steel or other structural metal compatible with fastened materials and approved by the Manufacturer. Size and fastening methods to be recommended by Manufacturer of product to meet Project requirements, fastening conditions, and structural performances. If any exposed devices, exposed portions to match color of primary resilient cap, unless otherwise acceptable to the University.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. **Examination:** Ensure metal framing supports have been installed in concealed cavities so fastening of each work is not fastened to non-structural finishes, e.g. gypsum board.

B. **Surface Preparation:** Clean and prepare surfaces in accordance with Guard Manufacturer's project specific requirements.

3.02 **INSTALLATION:**

A. **General:** Secure guards to adjacent construction in accordance with Shop Drawings successfully reviewed by the University and in accordance with each Guard Manufacturer's Project specific instructions. Guards to be continuous along full length of construction, unless otherwise indicated or acceptable to the University.

3.03 **DEFECTS, CLEANING & PROTECTIONS:**

A. **General:** Comply with Division 1 requirements.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Signage.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 8 – Hollow Metal Doors & Frames.
      3. Division 9 – Metal Support Assemblies.
      4. Division 9 – Gypsum Board.
      5. Sections covering other substrates and supports to signage are installed.

1.03 SYSTEM DESCRIPTION:
   A. Design Intent: As indicated on the Drawings. Anchorage methods to be concealed, unless otherwise acceptable to the University. Adhesive methods to be types based on the College standards or otherwise acceptable to the University.
   B. College Signage Standard: Verify College standards and include impacts in the Bid.

1.04 SUBMITTALS:
   A. Product Data:
      1. General: For each sign type required, submit product data for all materials and installation specifications, material tested performances and Project required finishes.
      2. Selected Characteristics: Submit data for selection by the University for any characteristics, e.g. colors, textures, font types and sizes, that have not been selected by the University or not part of the College signage standard, or both.
B. **Shop Drawings:** Submit. Show plans, elevations, and details indicating all signage characteristics and method of anchorage of each signage type to adjacent work. Show specific to scale data required on each sign.

C. **Samples:** For each signage type, submit Project representative finished samples for review of quality of work to be provided. Submit signage showing typical methods of anchorage to be used for each signage type.

1.05 **QUALITY ASSURANCE:**

A. **Manufacturer Qualifications:** Comply with Division 1 Requirements.

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### PART 2 - PRODUCTS

2.01 **MATERIALS:**

A. **General:** Comply with College Campus standards.

B. **Sign Types and Design:** As indicated on the Drawings.

2.02 **RELATED MATERIALS:**

A. **Anchorage Devices:** As accepted in submittals by the University.

2.03 **FABRICATION:**

A. **General:** Comply with Sign Manufacturer’s or Sign Fabricator’s Project specific requirements as fully submitted and successfully reviewed by the University in submittals.

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### PART 3 - EXECUTION

3.01 **INSTALLATION:**

A. **General:** Install each sign in strict accordance with the Identifying Devices Manufacturer’s or Fabricator’s Project specific requirements as fully submitted and successfully reviewed by the University. Locate and place work is plumb, level and in proper alignment.

3.02 **DEFECTS, CLEANING & PROTECTIONS:**

A. **General:** Comply with Division 1 requirements.

END OF SECTION
SECTION 11601 - LABORATORY EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

A. General: As specified in Section 01001.

B. Scope: This Section includes furnishing and installing equipment and accessories as shown on Drawings and as specified herein. The Work includes the following:

Laboratory Equipment

<table>
<thead>
<tr>
<th>EQ#</th>
<th>DESCRIPTION</th>
<th>FURNISH BY</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Stainless Steel Service Chase</td>
<td>CFCI</td>
<td>Full height</td>
</tr>
<tr>
<td>E2</td>
<td>Not Used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>Prep-Procedure Table</td>
<td>CFCI</td>
<td>Abutted to service chase</td>
</tr>
<tr>
<td>E4</td>
<td>Treatment Table</td>
<td>CFCI</td>
<td>Abutted to service chase</td>
</tr>
<tr>
<td>E5</td>
<td>Stainless Steel Scrub Sink</td>
<td>CFCI</td>
<td>Single bay w/ eyewash</td>
</tr>
<tr>
<td>E6</td>
<td>Stainless Steel Run Door</td>
<td>CFCI</td>
<td></td>
</tr>
<tr>
<td>E7</td>
<td>Drug Dispensary Safe</td>
<td>CFCI</td>
<td></td>
</tr>
<tr>
<td>E8</td>
<td>Surgical Light</td>
<td>CFCI</td>
<td>Double head, ceiling mt’d</td>
</tr>
<tr>
<td>E9</td>
<td>Procedure Light</td>
<td>CFCI</td>
<td>Ceiling mounted</td>
</tr>
</tbody>
</table>

Equipment to building utilities to be by Divisions 15 and 16

C. Design Intent: Drawings and Specifications outline the design intent and the general requirements of laboratory equipment. Construction details and component specifications for each product may not be complete. Equipment furnished shall be complete for the intended function and operation.

D. Related Sections: The following sections contain requirements that relate to this section.

1. Rough openings, pits, substrate preparation, and blockings for equipment installation shall be provided as specified in other Sections
2. Section 12353 – Laboratory Casework and Furnishings
3. Division 9 – Wall backing in metal stud partition framing
4. Division 15 – Plumbing: rough-ins, controls, and final connections
5. Division 15 – Mechanical: rough-ins, controls, and final connections
6. Division 16 – Electrical: Rough-ins and final connections

1.02 REFERENCE:

A. American National Standard Institute (ANSI)
B. Underwriter’s Laboratories, Inc. (UL)
C. National electric Code (NEC)
D. American Society for Testing and Materials (ASTM)
E. National Fire Protection Association (NFPA)
G. American Society of Heating Refrigeration, and Air conditioning Engineers, Inc. (ASHRAE)
H. As applicable to individual equipment

1.02 SUBMITTALS:
A. General: Submit in compliance with Division 1.
B. Specifications: Submit copy of item specification (from this document) and clearly note in bold print any modifications.
C. Product Data. Submit manufacturer’s specifications and installation instructions for each item of laboratory equipment furnished. Indicate on product data which optional devices and operations are proposed for inclusion with equipment. Where substitutions for specified items of laboratory equipment are proposed, submit data substantiating the proposed equipment is equal to that specified. Manufacturer’s specifications shall contain a full, detailed explanation of variations in operating and/or performance requirements.
D. Shop Drawings. In addition to work shown on manufacturer’s printed product data, submit dimensional roughing-in drawing, at minimum scale of $\frac{1}{8}" = 1"$-0", showing equipment placed in actual project site conditions adjacent to other equipment and relationship to other Sections of the Work, as well as mechanical and electrical requirements. Rough-in drawings shall clearly indicate where equipment connection varies from relevant trade contractor supply source. Submit dimensioned fabrication drawings for custom fabricated equipment, including plans, elevations, and sections, at minimum scale of $\frac{3}{4}" = 1"$-0", showing materials and gauges used. Indicate backing locations for anchorage to structure and partitions.
E. Samples. Submit samples of exposed finishes when requested by Owner’s Representative.
F. Non-Structural Lateral Force Design: Where indicated submit detailed seismic anchorage and attachment drawings and calculations provided by a Hawai’i-licensed Structural Engineer in compliance with the applicable current Hawai’i Building Code. The submittal shall include:
1. Dimensions and location of the center of gravity of the component.
2. Weight assumed in the calculations including contents.
3. Specification of anchorage to concrete in detail, including inspection and testing requirements, if any (inspection and testing to be furnished under this section, if required).

4. Reaction loads to the supporting structure, partition, or other component.

5. If a component other than the structure is used for seismic support, the submittal shall show the adequacy of the load path to the structure or otherwise demonstrate compliance with limitations in the contract documents.

6. Anchorage systems(s) description and application to specific equipment

G. Quality Control: Submit the following quality control documents:

1. Manufacturer's Qualifications. Letter confirming required minimum experience, references and service response time.

2. Applicable standards approval from NEMA, NEC, UL, ETL or as specified with the individual equipment items.

3. Written certification that manufactured finish complies with specified criteria.

4. Installer qualifications per paragraph 1.4, herein

H. O&M Manuals: Provide Operations and Maintenance manuals per Division 1 for each equipment type/model that describe operating procedures, maintenance (including teardown), replacement schedules, components parts list, and nearest local factory representative (include phone number) for components and emergency repairs. Provide a minimum of three complete manuals of each, bound and indexed.

1.03 QUALITY ASSURANCE:

A. Basis of Design: Requirements may differ from manufacturer’s standard product. Make modifications necessary to comply with specified requirements. Design is based upon primary manufacturer’s model first listed. Dimensions, electrical requirements, and utility connections are based on the item specified. Modifications to the design (incl. dimensional adjustments and utility services) or installed work may be necessary, at Contractor’s expense including design changes that differ from Contract Documents, if other listed or non-listed ‘or equal’ equipment is accepted and utilized.

B. Inspection: Equipment may be inspected by The University’s representative at the manufacturer’s plant prior to shipment per Division 1. Provide The University’s representative two (2) week prior notice to factory testing.

C. Experience: Manufacturer shall be a firm having an established organization and factory, with production facilities specializing in the type of equipment specified, having an internal engineering department and six (6) similar installations of equal scope and complexity completed in the previous three (3) years. Manufacturer shall have the demonstrated ability to produce the specified equipment of the required quality and a proven capacity to complete an installation of this size and type within the required time limits. Service response time to a telephone inquiry shall be same day (or within 4 hours, whichever is less) followed up by a factory trained technician at the site within 24 hours of the telephone inquiry; serviceable components
warehoused or readily available to service personnel; and fast access to shop drawings of equipment in field.

D. **Installer Qualifications:** Manufacturer, or approved in writing by manufacturer.

E. **Training:** For fabrication and installation of Work, use personnel who have received training and have previously fabricated or installed the specified equipment.

F. **QC Plan:** A Quality Control (QC) Plan shall be implemented for this work in accordance with the provisions in Division 1. Work of this Section shall be conducted in compliance with all relevant provisions contained in this section and division 1, including shop drawings, product data and samples, testing and inspection, reports, quality assurance, as-built documents and warranties.

1.04 **PROJECT CONDITIONS:**

- **Review** surfaces and conditions under which equipment is to be installed. Verify measurement of space for equipment and means of access for installation prior to start of building construction. Verify that service rough-ins and backing plates are in place. Report to The University’s representative, in writing, all items that may be detrimental to equipment delivery, installation or operation.

1.05 **JOB CONDITIONS:**

- **Drawings:** Drawings show arrangement and location of items of equipment. If it is necessary to vary from arrangement shown, because of structural, mechanical, electrical or other considerations, make such variations only after approval of The University’s representative and at no additional cost to The University.

- **Verification:** Verify dimensions at building. Report to The University’s representative, in writing, that equipment will be able to be moved through the building in order to reach its designated location. Measure recesses and openings at building and provide trim pieces, fillers and closures in sizes required.

1.06 **GUARANTEE:**

- **Guarantee:** Furnish to The University a written guarantee, for each equipment item noted under the following paragraph “Laboratory Equipment”, against defects in materials and workmanship without limitation for the number of years noted. Refer to Division 1 for warranty requirements.

1.07 **MAINTENANCE SERVICE:**

- **Maintenance Agreement:** The University will contract separately for maintenance service outside the warranty period. Contractor shall ensure that The University is to receive no adverse treatment regarding parts if The University chooses not to purchase the maintenance agreement from Vendor.

- **Initial Maintenance Service:** Beginning at Substantial Completion, provide 12
months' full maintenance by service technicians of laboratory equipment installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment operation. Provide parts and supplies as used in the manufacture and installation of original equipment. Perform maintenance, including emergency callback service, during normal working hours.

C. **Response Time:** Equipment supplier shall provide a technical response (actual presence or by phone) within 4 hours or the service call will be provided at no cost to The University.

D. **Diagnostic Equipment:** Equipment supplier shall provide diagnostic equipment necessary for maintenance.

**PART 2 - PRODUCTS**

2.01 **MATERIALS:**

A. **Complete Installation:** Provide equipment complete with necessary supports, anchorage, stands, gages, valves, parts, and accessories required for a complete operating installation.

B. **Electrical Components:** Provide each item of equipment with internal electrical services necessary for proper operation including wiring, conduit, boxes, raceways, fittings, lamps, switches, device plates, etc., sized for single point connection to building services, complying with requirements of NEC and bearing UL labeling as required.

C. **Mechanical/Plumbing:** Provide each item of equipment with mechanical and plumbing services necessary for proper operation including piping, fittings, ductwork, troughs, accessories, and materials, installed for easy access and connection to respective building service.

D. **Finishes:** Provide each item of equipment fully finished by manufacturer with no additional finish or painting required after installation. Provide trim and closure pieces are required for a fully finished installation.

2.02 **IDENTIFICATION AND RESPONSIBILITY:**

A. **Responsibility:** Laboratory Equipment is specified with corresponding symbols designation responsibility which have the following meanings:

1. CFCI Contractor Furnished / Contractor Installed

B. **Contractor Furnished/Contractor Installed (CFCI):** contactor to purchase, receive, unload, dispose of crating materials, store, unpack, re-assemble, set-in-place, install, clean-up, and protect equipment. Deliver to site in manufacturer's original labeled containers. Contractor to provide fasteners, supports or other miscellaneous items necessary for compete installation. Provide and schedule on-site equipment demonstrations at the convenience of The University. Where
indicated manufacturer shall provide installation supervision coordinated by the Contractor.

2.03 EQUIPMENT LISTINGS – LABORATORY EQUIPMENT:

E1: STAINLESS STEEL SERVICE CHASE

A. Manufacturers:
   1. Suburban Surgical Company, Inc.
      275 Twelfth Street, Wheeling, IL 60090
      Phone: 800-323-7366
      www.suburbansurgical.com
   2. Shor-line
      5112 Osage Ave., Kansas City, KA 66105
      Phone: 951-371-8685
      www.shor-line.com
   3. TBJ Incorporated
      1671 Orchard Drive, Chambersburg, PA 17201
      Phone: 717-261-9700
      www.tbjinc.com

B. Product Description
   1. Full height stainless steel chase constructed of die-formed stainless steel and formed on a CNC machine for accuracy. Panels are engineered for tight-fitting joints. Joints are mechanically fastened to ensure a solid sturdy chase. Panels are removable for future utility modifications. Interior and exterior are stainless steel. Exterior is satin finish.
   2. Dimensions: 30” L x 30” W x 108” H
   3. Provide seismic calculations and anchorage.
   4. Provide units with recessed upper and lower cabinets. See drawings for locations.
   5. Unit to have adjustable collar at ceiling to allow for installation at a 9’-0” ceiling.
   6. Coordinate with Division 15 for water and drain service. Coordinate with Division 16 for electrical outlet and light switch locations.

C. Utility Requirements
   1. Unit will house hot water, cold water, drain, and electrical.

D. Basis of Design: Suburban Surgical Regal full height chase

E2: NOT USED

E3: STAINLESS STEEL PREP-PROCEDURE TABLE

A. Manufacturers:
   1. Suburban Surgical Company, Inc.
E4: STAINLESS STEEL RECESSED END TREATMENT TABLE

A. Manufacturers:
   1. Suburban Surgical Company, Inc.
      275 Twelfth Street, Wheeling, IL 60090
      Phone: 800-323-7366
      www.suburbansurgical.com
   2. Shor-line
      5112 Osage Ave., Kansas City, KA 66105
      Phone: 951-371-8685
      www.shor-line.com
   3. TBJ Incorporated
      1671 Orchard Drive, Chambersburg, PA 17201
      Phone: 717-261-9700
      www.tbjinc.com

B. Product Description:
   1. Stainless steel treatment table abutted top and stainless steel cabinets below.
2. Stainless steel cabinets below with hinged cupboard door unit, 3-drawer unit and knee space.
3. Dimension: shall not exceed 50.625"L x 29.125" W x 36"H.

C. **Basis of Design:** Suburban Surgical Regal treatment table model #Y60HA01B1U0E0A3, door hinged right. Or equal.

**E5: STAINLESS STEEL SCRUB SINK**

A. **Manufacturers:**
   1. Skytron
   5085 Corporate Exchange Blvd. SE, Grand Rapids, MI 49512
   Phone: 800-759-8766
   www.steris.com
   2. Getinge USA, 1777 East Henrietta Road
   Rochester, NY 14623-3133
   Phone: 800-475-9040
   www.getingeusa.com
   3. Or Approved Equal

B. **Product Description:**
   1. Single bay clinical scrub sink constructed of heavy gage stainless steel.
   2. Provide optional eye wash feature
   3. Standard knee kick activation
   4. Deck mounted mixing valve
   5. Deep sloped sink design to minimize backsplash
   6. Provide optional wall support system and blending valve.

C. **Utility Requirements:**
   1. CW: ½"
   2. HW: ¼",
   3. Drain 1-1/2" waste terminal tailpiece
   4. TW ½" tepid water for eye wash

D. **Basis of Design:** Skytron model SS2121-MK-EW.

**E6: STAINLESS STEEL RUN DOOR ASSEMBLY**

A. **Manufacturers:**
   1. VSSI
   #1 Civil War Rd. Area 5, PO Box 431, Carthage, MO 64836
   Phone: 800-299-9525
   www.vssi.com
   2. Britz and Company
   Wheatland, WY
   Phone: 800-808-5609
   www.britzco.com
   3. Allentown Caging Company
   165 Route 526, Allentown, NJ 08501
4. or Equal

B. **Product Description:**
   1. Run door assembly for dog runs constructed of 1" stainless steel square tube frames and 3/8" diameter stainless steel rods.
   2. Dimensions: 47.37"W x 72"H

C. **Basis of Design:** VSSI run door assembly model #181-0001-10, SS8260LR, total length of 108", or Approved Equal.

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**E7: DRUG DISPENSARY SAFE**

A. **Manufacturers:**
   1. Buddy Products
      1350 S. Leavitt, Chicago, IL 60608
      Phone: 800-312-733-6400
      [www.buddyproducts.com](http://www.buddyproducts.com)
   2. or pre-approved equal

B. **Product Description:**
   1. Drug safe with heavy duty steel and electronic keypad lock.
   2. Dimensions: 20"W x 6"D x 20"H
   3. Adjustable shelving.
   4. Programmable digital lock with override feature.
   5. Provide 2 keys for manual locking and unlocking
   6. Provide mounting hardware

C. **Basis of Design:** Buddy Products Platinum drug dispensary safe # BDD-3222-32 or Equal.

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**E8: SURGERY ROOM LIGHT**

A. **Manufacturers:**
   1. Philips Burson
      21100 Lassen Street, Chatsworth, CA 91311
      Phone: 818-701-8700
      [www.burtonmedical.com](http://www.burtonmedical.com)
   2. Getinge USA, 1777 East Henrietta Road
      Rochester, NY 14623-3133
      Phone: 800-475-9040
      [www.getingeusa.com](http://www.getingeusa.com)
   3. Skytron
      5085 Corporate Exchange Blvd. SE, Grand Rapids, MI 49512
      Phone: 800-759-8766
      [www.skytron.com](http://www.skytron.com)
B. **Product Description:**
1. Ceiling mounted major surgery light with dual heads.
2. Each light head to provide 63,000 lux (5,800 fc) at 1 meter and 3,500 K color temperature.
3. Each light head uses (3) 35-watt quartz halogen bulbs rated at 2,000 hour bulb life. Bulbs wired in parallel.
4. 20” diameter light heads.
5. 360° limitless arm and mounting system rotation around vertical axis.
6. Sterilizable/autoclavable handle
7. Provide seismic bracing calculations and anchorage
8. 5 year warranty

C. **Utility Requirements:** 120V / 1Ph

D. **Basis of Design:** Philips Burton AIM-100 ceiling mounted, dual head surgery light.

E9: **EXAM LIGHT**

A. **Manufacturers:**
1. Skytron
   5085 Corporate Exchange Blvd. SE, Grand Rapids, MI 49512
   Phone: 800-759-8766
   www.skytron.com
2. Philips Burson
   21100 Lassen Street, Chatsworth, CA 91311
   Phone: 818-701-8700
   www.burtonmedical.com
3. Getinge USA, 1777 East Henrietta Road
   Rochester, NY 14623-3133
   Phone: 800-475-9040
   www.getingeusa.com
4. or Equal

B. **Product Description:**
1. Exam light with 9" diameter single light head, mounted to ceiling with radial arm.
2. Featherlight polymer light head is sealed for easy wipe-down.
3. Light head mounted on/off and intensity control
4. Sterilizable positioning handle to be included.
5. High intensity illumination with up to 45,000 lux (4,200 fc) at a working distance of 42”.
6. Bulb: 24v, 75W halogen bulb that can be easily changed.
7. Provide seismic bracing calculations and anchorage.
8. 5 year warranty

C. **Basis of Design:** Skytron Stellar Series ST-9 ceiling mounted exam light.
PART 3 - EXECUTION

3.01 PREPARATION:

A. **Shipping Damage**: Check for shipping damage. Reject units with scratches, dents or other defects that cannot be readily corrected.

B. **Prior to start of Work**: Examine surfaces and areas to receive equipment to insure that rough-ins and substrates are correct, that equipment will fit as indicated on Drawings, that surfaces and clean, dry and that preparatory Work is complete.

C. **Proceed with Work** when conditions will permit installation in accordance with the original design, accepted submittals, and the manufacturer’s printed instruction and defects or oversight are corrected.

3.02 INSTALLATION:

A. **Delivery**: Deliver equipment to the job site freight paid.

B. **Uncrate** equipment and place in locations shown on drawings. Remove crating materials and packing debris.

C. **Installation Standards**: Install items in accordance with Manufacturer’s standards. Provide accessories necessary for a complete installation.

D. **Applicable Codes**: Install to meet Applicable Codes for seismic requirements.

E. **Coordination with Other Trades**: Coordinate connections with work of Divisions 15 and 16.

3.03 ADJUST AND CLEAN:

A. **Check and Adjust**: Check operation and installation of equipment. Make adjustments as necessary to meet Manufacture’s or these specifications (whichever is more stringent).

B. **Replacement**: Replace items which do not operate properly, have defacing marks or damage which cannot be satisfactorily repaired as determined by The University’s representative. Replace parts at no cost to The University.

C. **Cleaning**: Clean and polish equipment in accordance with Manufacturer’s recommendations before and after demonstration for The University’s representative. Leave ready for use with copy of instructions manual attached to equipment in a manner to be specified by The University’s representative.

3.04 SERVICE CONTRACT:

A. Submit with Proposal a list of available accessories for The University’s information. Provide unit prices for these accessory items.
B. **Service Contract**: Manufacturer shall submit a service contract for his piece of equipment and cost of same. The University’s representative shall determine if contracts are to be accepted.

3.05 **TRAINING:**

A. **Onsite**: Provide training on site by factor authorized representative for up to six people in proper use and maintenance of equipment.

B. **Hands-On Session**: Provide a hands-on, start-up session with supplier, maintenance personnel, and end users. There shall be a separate operational session and maintenance session.

3.06 **PROTECTION:**

A. **Protection of Equipment**: Units shall be protected after installation during remainder of construction.

3.07 **FIELD QUALITY CONTROL:**

A. **Tests and Inspections**: Tests and special inspections required by the design of seismic restraints shall be provided by the University. Contractor shall provide schedule of installation and required testing to University’s field representative.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Steel wall and base cabinets.
      2. Stainless steel countertops.
      3. Epoxy countertops.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 9 – Metal Support Assemblies.
      3. Division 9 – Gypsum Board.
      4. Division 9 – Seamless Epoxy-Quartz Flooring.
      5. Division 16 Sections.

1.03 SUBMITTALS:
   A. Product Data:
      1. General: Submit product data for each casework equipment,
         countertops and hardware required. Coordinate with Shop Drawing
         submittals.
      2. Available Options: Submit data on available options for selection by
         the University.
   B. Shop Drawings: Submit.
      1. Show plans, elevations, and details indicating all equipment required
         and the location of each.
      2. Show relationship to adjacent work.
      3. Show location of concealed blocking or framing, or both.
      4. Show location of service fittings.
C. **Samples:** Submit Project representative samples of each finish as follows.
   1. **Scheduled Finishes:** 8-1/2” x 11” samples. Where custom finish required, verify each and submit samples.
   2. **Non-Scheduled Finishes:** Submit range of available finishes for selection by the University.
   3. **Hardware:** Submit hardware pull samples for review by the Architect.

1.04 **QUALITY ASSURANCE:**

A. **Manufacturer Qualifications:** Comply with Division 1 Requirements.

B. **Installer Qualifications:**
   1. **General:** Comply with Division 1 requirements.
   2. **Manufacturer Approval:** Submit each Product Manufacturer’s written approval of the Installer as having the requisite experience to install the Project products in accordance with their Project specific requirements.

C. **Contractor Responsibility:** Provide concealed metal framing for support of all wall cabinets. Do not allow wall cabinets to be hung on gypsum board alone.

D. **Variations in Product Characteristics:** Subject to preapproval, slight variations in product equal characteristics will be allowed by the University as long as there is no design feature or Authority requirement, or both, about a product that would be not acceptable for the Project.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

A. **Basis of Design:** Thermo Fisher Scientific.

B. **Preapproved Equals:** From one of the following.
   1. Kewaunee.
   2. Formaspace.
   4. Jamestown Metal Products.

2.02 **STEEL CABINETS – COMMON CHARACTERISTICS:**

A. **Type:** Flush overlay, all steel construction.
B. Performance Characteristics:

1. General: Complies with SEFA 8 Standards.

2. Load Capacity:
   a. Wall Cabinets: 300 lbs.
   b. Base Cabinet: 500 lbs.
   c. Doors: 150 lbs. dynamic load applied 12" from the hinge.
   d. Drawers: 150 lbs.
   e. Shelves: 40 psf with 200 lbs. maximum load to 48" width.

C. Minimum Gages:

1. 20 Gage: Exterior and interior drawer fronts, interior door panels, scribing strips, filler panels, enclosures, drawer bodies, shelves, security panels and sloping tops.
2. 18 Gage: Door fronts, case tops, ends, bottoms, bases, backs, vertical posts, uprights, and access panels.
3. 16 Gage: Top front rails, top rear gussets, intermediate horizontal rails and stretchers.
4. 14 Gage: Drawer suspensions, door and case hinge reinforcements and front corner reinforcements.
5. 11 gauge: Gussets for leveling screws.

D. Hardware:

1. General: Manufacturer’s standard hardware for each cabinet type. Where optional hardware available provide full range of standards for each line for selection by the University.
2. Pulls: To be selected by the University from full range of available types and styles. Provide one per door leaf and drawer unit minimum.
4. Door Hinges: Institutional type, 5 knuckle, Type 304 stainless steel. Pair minimum per each door leaf, but not less than required by Manufacturer for each door leaf height and weight.
5. Door Catches: Manufacturer’s standards. Where more than one type, the University to select from options.
6. **Locks:** Standard Grand Master keyable locks with removable cores and provided with three brass or bronze keys minimum each lock and each Masterkey level; keyed to the University requirements.

E. **Paint Finish Performances:**

1. **Paint Type:** Manufacturer’s standard powder or baked-on enamel process capable of meeting the specified performances.

2. **Color and Sheen:** Custom color and semi-gloss minimum sheen to be selected by the University.

3. **Abrasion resistance:** Maximum weight loss of 5.5 mg. per 100 cycle when tested on a Taber Abrasion Tester #E40101 with 1000 gm wheel pressure and Calibrase #CS10 wheel.

4. **Hardness:** Equivalent to 4H or 5H pencil.

5. **Humidity resistance:** Withstand 1000 hour exposure in saturated humidity at 100 degrees F.

6. **Moisture resistance:**
   
a. No visible effect to surface finish after boiling water trickled over test panel inclined at 45 degrees for five minutes.

b. No visible effect to surface finish following 100 hour continuous application of a water soaked cellulose sponge, maintained in a wet condition throughout the test period.

7. **Adhesion:** Score finish surface of test panel with razor blade into 100 squares, 1/16" x 1/16", cutting completely through the finish but with minimum penetration of the substrate, and brush away particles with soft brush. Minimum 90 squares shall maintain their finish.

8. **Salt spray:** Withstand minimum 200 hour salt spray test.

2.03 **STEEL CABINETS – WALL CABINETS:**

A. **Typical Characteristics:**

1. **Carcass:** Fully enclosed unit with sides, flush tops, flush soffit bottoms and backs.

2. **Glazing:** 6mm tempered clear safety glass.

3. **Shelves:** Two adjustable shelves minimum for each cabinet capable of adjustments at 1/2” increments.

4. **Hangers:** Integral hangers to attached to wood wall cleats.

B. **Wall Cabinet Sizes:**
1. **Pair Flush Doors:**
   a. **Product:** 706J6330.
   b. **Size:** 13” depth x 36” width x 31” height.

2. **Pair Framed Glass Doors:**
   a. **Product:** 712J6330L.
   b. **Size:** 13” depth x 36” width x 31” height.

### 2.04 STEEL CABINETS – BASE CABINETS:

**A. Typical Characteristics:**

1. **Carcass:** Fully enclosed unit except open top.
2. **Doors:** Outer and inner pan construction with internal cavity full height channel reinforcements and sound deadening filler between channels.
3. **Drawers:** Standard height above each door leaf x same width as each door leaf.
4. **Shelf:** One adjustable shelf minimum for each cabinet capable of adjustments at 1-1/4" increments.

**B. Base Cabinet Size:** 21-1/8” x 36” width x 32-5/8” height in following product configurations.

1. **Pair Top Drawers and Pair Flush Doors:** 348J5720.
2. **Sink Cabinet with Pair Flush Doors:** 025J6720.
3. **Sink Cabinet for ADAAG Access:** 950J0220.

### 2.05 STEEL CABINETS – ACCESSORIES:

**A. Kneespace Panels and Kneespace Rails:** 616J6720 with finish matching each base cabinet for which panels and rails are scheduled to be installed.

### 2.06 COUNTERTOPS – STAINLESS STEEL:

**A. Material:**

1. **General:** All AISI Type 304 stainless steel construction complying with Division 5 – Metal Fabrications – Stainless Steel Section.
2. **Gage:** 16 or thicker.
3. **Finish:** #4, unless otherwise indicated.

**B. Configuration:** As indicated and formed from single monolithic sheet with underside reinforcements to prevent deflection of counters under loading,
unless otherwise acceptable to the University. Provide with 1” depth front lip and integral 6” height backsplash. Provide sound deadening material concealed on underside of each countertop.

2.07 COUNTERTOPS – EPOXY:

A. Material:
   1. General: Monolithic cast epoxy countertop.
   2. Thickness: 1” minimum.
   3. Finish: Standard finish and gloss.
   4. Color: Black, unless other color is scheduled.

B. Configuration: As indicated and formed from a single monolithic cast sheet, unless otherwise acceptable to the University. Provide following additional features.
   1. 6:” height backsplash butt jointed and continuously cemented to countertop surface.
   2. Drip groove on underside of counter leading edge.

C. Performances: Tested for over 66 caustic chemicals with majority having "No Effect" and with a “Poor” evaluation when subjected to various sulfuric acid concentrations.

2.08 RELATED MATERIALS:

A. Leveling Devices: For floor set work, e.g. base cabinets or tables, provide leveling devices with 3/8”-16 threads, 2” minimum diameter minimum cushioned base, 3” overall height minimum, and with tested load rating based on distributed load capacity of the cabinet and its weight on the number of load points, but not less than four leveling devices for each work.

B. Fillers: Provide as needed to close off open joints between casework units and adjacent construction. Fillers to be fabricated to match material and finish of each casework equipment and be provided with hemmed or flanged edges as appropriate for each type of closure.

C. Sound Dampening Material: Cabinet and countertops to be provided with the Manufacturer’s standard sound dampening, flame resistant materials in hollow cavity and other locations.

2.09 FABRICATION:

A. General: Fabricate all work in the Shop. Manufacturer’s standard construction, unless otherwise specified. No field cutting or drilling allowed.

B. Epoxy Countertops:
1. **Exposed Edges:** Bevel.

2. **Joints Between Adjacent Tops:** If any, 1/8" maximum joints fully sealed watertight upon field completion of the work.

**PART 3 - EXECUTION**

3.01 **INSTALLATION:**

A. **General:** Install each specialty casework in strict accordance with the Specialty Casework Manufacturer's Project specific requirements as fully submitted and successfully reviewed by the University. Locate and place work is plumb, level and in proper alignment.

B. **Adjustment:** Adjust each work after installation for proper, smooth and non-binding operation. Lubricate components if required.

3.02 **DEFECTS, CLEANING & PROTECTIONS:**

A. **General:** Comply with Division 1 requirements.

**END OF SECTION**
SECTION 13185 – KENNELS & ANIMAL SHELTERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Stainless steel, sliding kennel gates.
   B. Related Sections:
      1. Division 1 Sections.
      2. Division 4 – Concrete Masonry Units.
      3. Division 5 – Metal Fabrications – Stainless Steel.
      4. Division 9 – Seamless Epoxy-Quartz Flooring.

1.03 SUBMITTALS:
   A. Product Data:
      1. General: Submit product data on all metal components and hardware used in each product. Indicate gage of each primary metal component and size. Provide data on finishes.
      2. Hardware: Provide data on each hardware.
   B. Shop Drawings: Submit as required for proper fabrication and installation of units, e.g., each layout, details of components and anchorage coordinated with adjacent work.
   C. Samples: Submit Project representative samples of following.
      1. Panels: Submit 8-1/2” x 11” partial mockup of typical sample for review of quality of welds and each finish.
      2. Hardware: Submit samples of hardware.

1.04 WARRANTY:
   A. General: Refer to Division 1 requirements.
PART 2 - PRODUCTS

2.01 MATERIALS:

A. General: Comply with Division 5 – Metal Fabrications – Stainless Steel Section.

B. Cross Sectional Thickness: Manufacturer’s standard thickness, but not less than following.
   1. Tube and Sheet: 16 gage minimum.

C. Finish: Manufacturer’s standard polished or #4 finish.

2.02 STAINLESS STEEL SLIDING GATES:

A. Products: One of following.
   1. Basis of Design:
      a. Manufacturer: VSSI, Inc.
   2. Other Available Manufacturers: Subject to compliance with the requirements, preapproved equals from any of the following.
      a. Direct Animal Products, Div. of TriStar Metals, Inc.
      b. LGL Animal Care Products, Inc.
      c. Mason Company.
      d. Tensile Strength: ASTM D 638, 6.0 x 10^3 psi.

B. Primary Characteristics:
   1. Size: Fits clear opening width and height sizes as indicated with door that provides 24” wide minimum clear opening.
   2. Metal Components: All metal components used on any part of product assemblies to be AISI Type 304 or 316 alloy. Metal components of lesser stainless steel to be approved by the University. No ferrous components are allowed.
   3. Hardware:
      a. Lockset: Manufacturer’s standard latching mechanism with provision of for padlock or integrated key locking mechanism.
b. **Trolley Assembly**: Manufacturers standard sliding trolley assembly engineered for weight of each door and heavy duty, long term performance.

### 2.03 FABRICATION:

A. **General**: Comply with Division 5 – Metal Fabrications – Stainless Steel Section. Products may be standard products of the specified Manufacturer or custom products complying with the requirements.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION:

A. **Verification of Conditions**: Ensure substrates are in compliance with requirements, including tolerances.

#### 3.02 INSTALLATION:

A. **General**: Comply with Kennel Unit Manufacturer’s Project specific requirements as fully submitted and successfully reviewed by the University; including for layout.

#### 3.03 DEFECTS, PROTECTIONS & CLEANING:

A. **General**: Comply with Division 1 requirements.

END OF SECTION
DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13282 - LEAD-CONTAINING PAINT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

General: As specified in Section 01001.

1.02 LEAD-CONTAINING PAINT NOTES

The paints on the existing exterior pipes along the north wall of Hale Imiloa at the Windward Community College have been found to contain lead. The contractor shall comply with the following:

A. Contractor’s employees disturbing and/or removing the paint must be informed that it contains lead and must have received the appropriate training in compliance with Federal and State lead standards.

B. The contractor shall be responsible for his/her employees’ personal protection, personal lead air monitoring and necessary records in accordance with HIOSH construction lead standards. The contractor must also conduct personal air monitoring for lead during this activity, unless the contractor has a valid negative exposure assessment for similar work.

C. Paint in good condition need not be removed prior to selective demolition/renovation activities except where the activities create airborne dust such as drilling, saw cutting, or surface preparation for repainting (cracking, peeling, flaking). 6 mil polyethylene must be placed in the work areas where these types of activities may occur to capture and contain the paint waste. Removal of lead-containing paint shall follow wet methods to minimize dust and no chemical striping of paint using methylene chloride shall be allowed. All paint waste must be containerized (DOT drum) and characterized for proper disposal (see item D).

D. The paint chip/debris (separated out or mixed with other construction debris) must be TCLP (Toxicity Characteristic Leachability Product) tested by the contractor to determine if it should be disposed of as hazardous waste or regular construction debris. If determined to be hazardous waste, then the waste manifest must be signed by the University’s Environmental Health and Safety Office’s Hazardous Materials Manager, Tim O’Callaghan (ph: 808-956-3198), and the manifest shall reflect the University’s EPA Generator # (Obtain from Tim O’Callaghan) before disposal. For the purposes of bidding, the contractor shall include the cost of the TCLP testing and disposal costs as regular construction debris. Should the TCLP test fail and the debris is considered hazardous waste, the University will issue a change order to the contractor to dispose of as hazardous waste.

TECHNICAL SPECIFICATIONS
Lead-Containing Paint
Project No. SW-12-6238

13282 - 1
E. The contractor's Qualified Consultant (a third party independent industrial hygiene consultant hired by the General Contractor) shall conduct visual inspection of the lead abatement area to ensure that the area is clean and free of visible lead dust.

PART 2 - PRODUCTS

(Not Used)

PART 3 – EXECUTION

(Not Used)

END OF SECTION
DIVISION 13 – SPECIAL CONSTRUCTION

SECTION 13930 - WET-PIPE FIRE-SUPPRESSION SPRINKLERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Pipes, fittings, and specialties.
      2. Fire-protection valves.
      3. Fire-department connections.
      4. Sprinklers.
      5. Alarm devices.
      7. Control panels.
      8. Pressure gages.

1.03 DEFINITIONS:
   A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.04 SYSTEM DESCRIPTIONS:
   A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.05 PERFORMANCE REQUIREMENTS:
   A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
B. **Delegated Design**: Design sprinkler system(s), including comprehensive engineering analysis by University, using performance requirements and design criteria from a contractor performed fire-hydrant flow test.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. **Margin of Safety for Available Water Flow and Pressure**: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. **Sprinkler Occupancy Hazard Classifications**:
   b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   d. Office and Public Areas: Light Hazard.
   e. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. **Minimum Density for Automatic-Sprinkler Piping Design**:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
   d. Special Occupancy Hazard: As determined by authorities having jurisdiction.

4. **Maximum Protection Area per Sprinkler**: Per UL listing.

5. **Maximum Protection Area per Sprinkler**:
   a. Office Spaces: 225 sq. ft.
   b. Storage Areas: 130 sq. ft.
   c. Mechanical Equipment Rooms: 130 sq. ft.
   d. Electrical Equipment Rooms: 130 sq. ft.
   e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
D. **Seismic Performance**: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.06 **ACTION SUBMITTALS**:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. **Product Data**: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. **Shop Drawings**: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

D. **Wiring Diagrams**: For power, signal, and control wiring.

E. **Informational Submittals**: Field quality-control reports.

F. **Closeout Submittals**: Operation and Maintenance Data for sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.07 **QUALITY ASSURANCE**:

A. **Installer Qualifications**: Installer’s responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant low test.

1. **University Responsibility**: Preparation of working plans, calculations, and field test reports by University.

B. **Welding Qualifications**: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. **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.

D. **NFPA Standards**: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
1.08 PROJECT CONDITIONS:
A. **Interruption of Existing Sprinkler Service**: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated.

B. Retain this article if interruption of existing sprinkler service is required.

C. Notify Owner no fewer than two days in advance of proposed interruption of sprinkler service

D. Do not proceed with interruption of sprinkler service without Owner's written permission

1.09 COORDINATION:
A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:
A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.02 STEEL PIPE AND FITTINGS:
A. **Standard Weight, Galvanized and Black-Steel Pipe**: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.


C. **Galvanized and Uncoated, Steel Couplings**: ASTM A 865, threaded.

D. **Steel Flanges and Flanged Fittings**: ASME B16.5, Class 150.

2.03 PIPING JOINING MATERIALS:
A. **Pipe-Flange Gasket Materials**: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.04 COVER SYSTEM FOR SPRINKLER PIPING:

A. Description: System of support brackets and covers made to protect sprinkler piping.

B. Brackets: Glass-reinforced nylon.

C. Covers: Extruded PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.05 LISTED FIRE-PROTECTION VALVES:

A. General Requirements:

1. Valves shall be UL listed or FM approved.


3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.

B. Ball Valves:


2. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.

3. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.

4. Valves NPS 3: Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:


4. End Connections: Threaded.

D. Iron Butterfly Valves:
1. **Standard**: UL 1091.
2. **Pressure Rating**: 175 psig.
3. **Body Material**: Cast or ductile iron.
4. **Style**: Lug or wafer.
5. **End Connections**: Grooved.

**E. Check Valves:**

1. **Standard**: UL 312.
2. **Pressure Rating**: 250 psig minimum.
3. **Type**: Swing check.
4. **Body Material**: Cast iron.
5. **End Connections**: Flanged or grooved.

**F. Bronze OS&Y Gate Valves:**

1. **Standard**: UL 262.
2. **Pressure Rating**: 175 psig.
3. **Body Material**: Bronze.
4. **End Connections**: Threaded.

**G. Iron OS&Y Gate Valves:**

1. **Standard**: UL 262.
2. **Pressure Rating**: 250 psig minimum.
3. **Body Material**: Cast or ductile iron.
4. **End Connections**: Flanged or grooved.

**H. Indicating-Type Butterfly Valves:**

1. **Standard**: UL 1091.
2. **Pressure Rating**: 175 psig minimum.
3. **Valves NPS 2 and Smaller:**
   a. **Valve Type**: Ball or butterfly.
b. **Body Material:** Bronze.
c. **End Connections:** Threaded.

4. **Valves NPS 2-1/2 and Larger:**
   a. **Valve Type:** Butterfly.
   b. **Body Material:** Cast or ductile iron.
   c. **End Connections:** Flanged, grooved, or wafer.

5. **Valve Operation:** Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

I. **NRS Gate Valves:**
   1. **Standard:** UL 262.
   2. **Pressure Rating:** 250 psig minimum.
   3. **Body Material:** Cast iron with indicator post flange.
   4. **Stem:** Nonrising.
   5. **End Connections:** Flanged or grooved.

J. **Indicator Posts:**
   1. **Standard:** UL 789.
   2. **Type:** Horizontal for wall mounting.
   3. **Body Material:** Cast iron with extension rod and locking device.
   4. **Operation:** Wrench or Hand wheel.

2.06 **TRIM AND DRAIN VALVES:**

A. **General Requirements:**

2. **Pressure Rating:** 175 psig minimum.

2.07 **SPECIALTY VALVES:**

A. **General Requirements:**
2. **Pressure Rating**: Standard-Pressure Piping Specialty Valves: 175 psig minimum.

3. **Body Material**: Cast or ductile iron.

4. **Size**: Same as connected piping.

5. **End Connections**: Flanged or grooved.

B. **Alarm Valves**:

1. **Standard**: UL 193.

2. **Design**: For horizontal or vertical installation.

3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

4. **Drip Cup Assembly**: Pipe drain without valves and separate from main drain piping.

5. **Drip Cup Assembly**: Pipe drain with check valve to main drain piping.

C. **Automatic (Ball Drip) Drain Valves**:

1. **Standard**: UL 1726.

2. **Pressure Rating**: 175 psig minimum.

3. **Type**: Automatic draining, ball check.


5. **End Connections**: Threaded.

2.08 **FIRE-DEPARTMENT CONNECTIONS**:

A. **Yard-Type, Fire-Department Connection**:

B. **Standard**: UL 405.

C. **Type**: Exposed, freestanding.

D. **Pressure Rating**: 175 psig minimum.

E. **Body Material**: Corrosion-resistant metal.

F. **Inlets**: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
G. **Caps**: Brass, lugged type, with gasket and chain.

H. **Escutcheon Plate**: Round, brass, floor type.

I. **Outlet**: Bottom, with pipe threads.

J. **Number of Inlets**: Two.

K. **Sleeve**: Brass.

L. **Sleeve Height**: 18 inches.

M. **Escutcheon Plate Marking**: Similar to “AUTO SPKR.”

N. **Finish, Including Sleeve**: Polished chrome plated.

O. **Outlet Size**: NPS 6.

2.09 **SPRINKLERS SPECIALTY PIPE FITTINGS:**

A. **Branch Outlet Fittings**:
   1. **Standard**: UL 213.
   2. **Pressure Rating**: 175 psig minimum.
   3. **Body Material**: Ductile-iron housing with EPDM seals and bolts and nuts.
   4. **Type**: Mechanical-T and -cross fittings.
   5. **Configurations**: Snap-on and strapless, ductile-iron housing with branch outlets.
   6. **Size**: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
   7. **Branch Outlets**: Grooved, plain-end pipe, or threaded.

B. **Flow Detection and Test Assemblies**:
   2. **Pressure Rating**: 175 psig minimum.
   3. **Body Material**: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
   4. **Size**: Same as connected piping.
   5. **Inlet and Outlet**: Threaded.
C. **Branch Line Testers:**
   1. **Standard:** UL 199.
   2. **Pressure Rating:** 175 psig.
   3. **Body Material:** Brass.
   4. **Size:** Same as connected piping.
   5. **Inlet:** Threaded.
   6. **Drain Outlet:** Threaded and capped.
   7. **Branch Outlet:** Threaded, for sprinkler.

D. **Sprinkler Inspector's Test Fittings:**
   2. **Pressure Rating:** 175 psig minimum.
   3. **Body Material:** Cast- or ductile-iron housing with sight glass.
   4. **Size:** Same as connected piping.
   5. **Inlet and Outlet:** Threaded.

E. **Adjustable Drop Nipples:**
   1. **Standard:** UL 1474.
   2. **Pressure Rating:** 250 psig minimum.
   3. **Body Material:** Steel pipe with EPDM-rubber O-ring seals.
   4. **Size:** Same as connected piping.
   5. **Length:** Adjustable.
   6. **Inlet and Outlet:** Threaded.

F. **Flexible, Sprinkler Hose Fittings:**
   1. **Standard:** UL 1474.
   2. **Type:** Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
   3. **Pressure Rating:** 175 psig minimum.
4. **Size**: Same as connected piping, for sprinkler.

### 2.10 SPRINKLERS:

**A. General Requirements:**


2. **Pressure Rating for Automatic Sprinklers**: 175 psig minimum.

3. All sprinkler heads located outside and exposed to elements shall have a corrosion coating.

**B. Automatic Sprinklers with Heat-Responsive Element:**

1. **Early-Suppression, Fast-Response Applications**: UL 1767.

2. **Nonresidential Applications**: UL 199.

3. **Characteristics**: Nominal 1/2-inch orifice with Discharge Coefficient $K$ of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

**C. Sprinkler Finishes:**

1. Chrome plated.

2. Bronze.

3. Painted.

**D. Special Coatings:**

1. Wax.

2. Lead.

3. Corrosion-resistant paint.

**E. Sprinkler Escutcheons**: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. **Ceiling Mounting**: Chrome-plated steel, one piece, flat.

2. **Sidewall Mounting**: Chrome-plated steel, one piece, flat.

**F. Sprinkler Guards:**

1. **Standard**: UL 199.
2. **Type**: Wire cage with fastening device for attaching to sprinkler.

2.11 **ALARM DEVICES**:

A. Alarm-device types shall match piping and equipment connections.

B. **Water-Motor-Operated Alarm**:

1. **Standard**: UL 753.

2. **Type**: Mechanically operated, with Pelton wheel.

3. **Alarm Gong**: Cast aluminum with red-enamel factory finish.

4. **Size**: 10-inch diameter.

5. **Components**: Shaft length, bearings, and sleeve to suit wall construction.


7. **Outlet**: NPS 1 drain connection.

C. **Water-Flow Indicators**:

1. **Standard**: UL 346.

2. **Water-Flow Detector**: Electrically supervised.

3. **Components**: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

4. **Type**: Paddle operated.

5. **Pressure Rating**: 250 psig.

6. **Design Installation**: Horizontal or vertical.

D. **Pressure Switches**:

1. **Standard**: UL 346.

2. **Type**: Electrically supervised water-flow switch with retard feature.

3. **Components**: Single-pole, double-throw switch with normally closed contacts.

4. **Design Operation**: Rising pressure signals water flow.
E. **Valve Supervisory Switches:**
   1. **Standard:** UL 346.
   2. **Type:** Electrically supervised.
   3. **Components:** Single-pole, double-throw switch with normally closed contacts.
   4. **Design:** Signals that controlled valve is in other than fully open position.

F. **Indicator-Post Supervisory Switches:**
   1. **Standard:** UL 346.
   2. **Type:** Electrically supervised.
   3. **Components:** Single-pole, double-throw switch with normally closed contacts.
   4. **Design:** Signals that controlled indicator-post valve is in other than fully open position.

2.12 **MANUAL CONTROL STATIONS:**
   A. UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening:

2.13 **CONTROL PANELS:**
   A. Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
   
   B. **Panels:** UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
   
   C. **Manual Control Stations:**
      1. **Electric Operation:** Metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
2. **Hydraulic Operation:** With union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.14 **PRESSURE GAGES:**

A. **Standard:** UL 393.

B. **Dial Size:** 3-1/2- to 4-1/2-inch diameter.

C. **Pressure Gage Range:** 0 to 250 psig minimum.

D. **Water System Piping Gage:** Include "WATER" or "AIR/WATER" label on dial face.

**PART 3 - EXECUTION**

3.01 **PREPARATION:**

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.02 **SERVICE-ENTRANCE PIPING:**

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.03 **WATER-SUPPLY CONNECTIONS:**

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in SECTION 15140 - DOMESTIC WATER PIPING.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.
3.04 PIPING INSTALLATION:

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with University before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Fill sprinkler system piping with water.
O. Install sleeves for piping penetrations of walls, ceilings, and floors.
P. Install sleeve seals for piping penetrations of concrete walls and slabs.
Q. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.05 JOINT CONSTRUCTION:
A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
K. **Steel-Piping, Cut-Grooved Joints**: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

L. **Steel-Piping, Roll-Grooved Joints**: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. **Steel-Piping, Pressure-Sealed Joints**: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

N. **Brazed Joints**: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

O. **Copper-Tubing Grooved Joints**: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

P. **Copper-Tubing, Pressure-Sealed Joints**: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

Q. **Extruded-Tee Connections**: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

R. **Dissimilar-Material Piping Joints**: Make joints using adapters compatible with materials of both piping systems.

3.06 **INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING:**

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

3.07 **VALVE AND SPECIALTIES INSTALLATION:**

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
D. **Specialty Valves:**

1. **General Requirements:** Install in vertical position for proper direction of flow, in main supply to system.

2. **Alarm Valves:** Include bypass check valve and retarding chamber drain-line connection.

3.08 **SPRINKLER INSTALLATION:**

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.09 **FIRE-DEPARTMENT CONNECTION INSTALLATION:**

A. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in structural specifications.

   1. Install protective pipe bollards around each fire-department connection.

B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.10 **IDENTIFICATION:**

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals.

3.11 **DEMONSTRATION:**

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 **PIPING SCHEDULE:**

A. **Piping between Fire-Department Connections and Check Valves:** Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE:

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Pendent sprinklers.
   4. Spaces Subject to Freezing: Pendent, dry sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
   3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. **Upright, Pendent and Sidewall Sprinklers:** Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, outside, chemicals, or other corrosive fumes.

END OF SECTION
DIVISION 15 - MECHANICAL

SECTION 15062 - HANGERS AND SUPPORTS PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Metal pipe hangers and supports.
      2. Trapeze pipe hangers.
      3. Pipe stands.
      4. Equipment supports.

1.03 DEFINITIONS:
   A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS:
   A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
      1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
      2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
      3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.05 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of product indicated.
1.06 QUALITY ASSURANCE:
   A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS:
   A. Carbon-Steel Pipe Hangers and Supports:
      1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
      2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
      3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
      4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   B. Stainless-Steel Pipe Hangers and Supports:
      1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
      2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   C. Copper Pipe Hangers:
      1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.02 TRAPEZE PIPE HANGERS:
   A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
2.03 PIPE STANDS:

A. **General Requirements for Pipe Stands:** Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. **Compact Pipe Stand:** One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. **Low-Type, Single-Pipe Stand:** One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. **High-Type, Single-Pipe Stand:**
   1. **Description:** Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. **Base:** Plastic or Stainless steel.
   3. **Vertical Members:** Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. **Horizontal Member:** Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. **High-Type, Multiple-Pipe Stand:**
   1. **Description:** Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. **Bases:** One or more; plastic.
   3. **Vertical Members:** Two or more protective-coated-steel channels.
   4. **Horizontal Member:** Protective-coated-steel channel.
   5. **Pipe Supports:** Galvanized-steel, clevis-type pipe hangers.

F. **Curb-Mounted-Type Pipe Stands:** Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.04 EQUIPMENT SUPPORTS:

A. **Description:** Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
2.05 MISCELLANEOUS MATERIALS:

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION:

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See SECTION 07720 – ROOF ACCESSORIES for curbs.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. **Load Distribution:** Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. **Pipe Positioning-System Installation:** Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

K. **Pipe Slopes:** Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. **Insulated Piping:**
   1. Attach clamps and spacers to piping.
      a. **Piping Operating above Ambient Air Temperature:** Clamp may project through insulation.
      b. **Piping Operating below Ambient Air Temperature:** Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. **Option:** Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. **Option:** Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. **Shield Dimensions for Pipe:** Not less than the following:
   a. **NPS 1/4 to NPS 3-1/2:** 12 inches long and 0.048 inch thick.
   b. **NPS 4:** 12 inches long and 0.06 inch thick.

5. **Thermal-Hanger Shields:** Install with insulation same thickness as piping insulation.

### 3.02 EQUIPMENT SUPPORTS:

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. **Grouting:** Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.03 METAL FABRICATIONS:

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. **Field Welding:** Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.04 ADJUSTING:

A. **Hanger Adjustments:** Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
3.05 **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 a minimum dry film thickness of 2.0 mils.

B. **Touchup:** Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in "Exterior Painting", "Interior Painting" and "High Performance Coatings" spec sections.

C. **Galvanized Surfaces:** Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 **HANGER AND SUPPORT SCHEDULE:**

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use carbon-steel pipe hangers and supports and attachments for general service applications.

E. Use stainless-steel or corrosion-resistant attachments for hostile environment applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. **Horizontal-Piping Hangers and Supports:** Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. **Adjustable, Steel Clevis Hangers (MSS Type 1):** For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. **Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3):** For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

3. **Steel Pipe Clamps (MSS Type 4):** For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. **Pipe Hangers (MSS Type 5):** For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

5. **Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6):** For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

6. **Adjustable, Steel Band Hangers (MSS Type 7):** For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

7. **Adjustable Band Hangers (MSS Type 9):** For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. **Adjustable, Swivel-Ring Band Hangers (MSS Type 10):** For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. **Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11):** For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

10. **Adjustable Pipe Saddle Supports (MSS Type 38):** For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

11. **Adjustable Pipe Roll and Base Units (MSS Type 46):** For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. **Vertical-Piping Clamps:** Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. **Extension Pipe or Riser Clamps (MSS Type 8):** For support of pipe risers NPS 3/4 to NPS 24.

2. **Carbon- or Alloy-Steel Riser Clamps (MSS Type 42):** For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. **Building Attachments:** Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. **Steel or Malleable Concrete Inserts (MSS Type 18):** For upper attachment to suspend pipe hangers from concrete ceiling.

2. **Top-Beam C-Clamps (MSS Type 19):** For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. **Side-Beam or Channel Clamps (MSS Type 20):** For attaching to bottom flange of beams, channels, or angles.

4. **Center-Beam Clamps (MSS Type 21):** For attaching to center of bottom flange of beams.
5. **Welded Beam Attachments (MSS Type 22):** For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. **C-Clamps (MSS Type 23):** For structural shapes.

7. **Top-Beam Clamps (MSS Type 25):** For top of beams if hanger rod is required tangent to flange edge.

8. **Side-Beam Clamps (MSS Type 27):** For bottom of steel I-beams.

9. **Steel-Beam Clamps with Eye Nuts (MSS Type 28):** For attaching to bottom of steel I-beams for heavy loads.

10. **Linked-Steel Clamps with Eye Nuts (MSS Type 29):** For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. **Malleable-Beam Clamps with Extension Pieces (MSS Type 30):** For attaching to structural steel.

12. **Welded-Steel Brackets:** For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. **Light (MSS Type 31):** 750 lb.
   b. **Medium (MSS Type 32):** 1500 lb.
   c. **Heavy (MSS Type 33):** 3000 lb.

13. **Side-Beam Brackets (MSS Type 34):** For sides of steel or wooden beams.

14. **Plate Lugs (MSS Type 57):** For attaching to steel beams if flexibility at beam is required.

15. **Horizontal Travelers (MSS Type 58):** For supporting piping systems subject to linear horizontal movement where headroom is limited.

K. **Saddles and Shields:** Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. **Steel-Pipe-Covering Protection Saddles (MSS Type 39):** To fill interior voids with insulation that matches adjoining insulation.

2. **Protection Shields (MSS Type 40):** Of length recommended in writing by manufacturer to prevent crushing insulation.

3. **Thermal-Hanger Shield Inserts:** For supporting insulated pipe.

L. **Spring Hangers and Supports:** Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. **Restraint-Control Devices (MSS Type 47):** Where indicated to control piping movement.

2. **Spring Cushions (MSS Type 48):** For light loads if vertical movement does not exceed 1-1/4 inches.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION
SECTION 15072 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Elastomeric hangers.
      2. Snubbers.
      3. Restriction channel bracings.
      4. Restriction cable bracings.
      5. Seismic-restraint accessories.
      6. Mechanical anchor bolts.
      7. Adhesive anchor bolts.

1.03 DEFINITIONS:
   C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).
   D. NFPA: National Fire Protection Association
   E. ASCE: American Society of Civil Engineers

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of product.
      1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
   
a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
   
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
   
1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the University responsible for their preparation. The University shall be licensed in the state that the project is located.
   
2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints. Seismic force calculations shall be based on the more severe of the IBC and NFPA 13.
   
3. Seismic-Restraint Details:
   
a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   
c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
1.05 INFORMATIONAL SUBMITTALS:

A. Submit in accordance with SECTION 01300 – SUBMITTALS.

B. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

C. Field quality-control reports.

1.06 QUALITY ASSURANCE:

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by the University.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D.

2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
a. Component Importance Factor \((I_p)\): 1.5.

b. Component Response Modification Factor \((R_p)\): Use Table 13.6-1 in ACSE 7-05 for each component.

c. Component Amplification Factor \((A_p)\): Use Table 13.6-1 in ACSE 7-05 for each component.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second) \((S_{DS})\): 0.655 per structural design notes.

4. Design Spectral Response Acceleration at 1.0-Second Period \((S_{D1})\): 0.256 per structural design notes.

5. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.

2.02 APPROVED MANUFACTURERS:

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

1. Vibro-Acoustics

2.03 ELASTOMERIC HANGERS:

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

3. Minimum deflection shall be 0.30”.
2.04 RESTRAINT CHANNEL BRACINGS:
   A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces. Rigid steel pipes may be used in lieu of steel channels.

2.05 RESTRAINT CABLE BRACINGS:
   A. Description: Galvanized steel 7x19 aircraft cable with a minimum safety factor of 4. One end shall be pre-assembled and the other to be assembled by the installing contractor with a mounting bracket, thimble and compression sleeve or wire rope clips.

2.06 SEISMIC-RESTRAINT ACCESSORIES:
   A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
   B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
   C. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.07 MECHANICAL ANCHOR BOLTS:
   A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Anchors bolt shall be approved for seismic loading by the ICC-ES.

2.08 ADHESIVE ANCHOR BOLTS:
   A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Anchors shall be approved for seismic loading by the ICC-ES.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 APPLICATIONS:

A. All installation techniques and hardware shall meet the requirements of the NFPA 13.

B. Restrain all main feed and cross mains regardless of diameter and all branch lines with a diameter of 2-1/2 in. and larger.

C. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

D. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

E. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION:

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or duct work resulting in stresses or misalignment.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet o.c.. The distance from the end of the pipe to the last brace shall not exceed 6 feet.

3. Lateral braces shall be allowed to act as longitudinal braces if they are within 24 in. of the center-line of the pipe braced longitudinal and the lateral brace is on a pipe of equal or greater size.
4. Space longitudinal supports a maximum of 80 feet o.c.. The distance from the end of the pipe to the last brace shall not exceed 40 feet.

5. Longitudinal braces shall be allowed to act as lateral braces if they are within 24 in. of the center-line of the pipe braced laterally and the longitudinal brace is on a pipe of equal or greater size.

6. Brace a change of direction longer than 12 feet.

D. Riser Restraints:

1. Tops of risers exceeding 3 feet in length shall be provided with a four-way brace (longitudinally and laterally).

2. Distance between four-way braces shall not exceed 25 feet.

3. Four-way bracing shall not be required for risers that penetrate intermediate floors where the clearance does not exceed the limits of NFPA 13.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members. C-type clamps shall not be used to attach braces to the building structure.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the University if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. **Wedge Anchors**: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. **Adhesive Anchors**: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 **ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:**

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.05 **INSPECTION:**

A. Upon completion, arrange to have the seismic and vibration control manufacturer or representative inspect and certify that all installations comply with the applicable building code(s). Submit certification to the University.

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. This Section includes the following:
      1. Isolation pads.
      2. Isolation mounts.
      3. Restrained elastomeric isolation mounts.
      4. Spring hangers.
      5. Restrained vibration isolation roof-curb rails.
      7. Restraining braces, cables and hardware.
      8. Anchor bolts

1.03 DEFINITIONS:
   C. ASCE: American Society of Civil Engineers

1.04 PERFORMANCE REQUIREMENTS:
   A. Wind-Restraint Loading:
      1. Basic Wind Speed: 105. per structural design notes.
      2. Building Classification Category: III. per structural design notes.
      3. Minimum 10 lbs./sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
   B. Seismic-Restraint Loading:
      1. Site Class as Defined in the IBC: C. per structural design notes.
2. **Seismic Design Category**: D. per structural design notes.

3. **Assigned Seismic Use Group or Building Category as Defined in the IBC**: III. per structural design notes.
   a. **Component Importance Factor**: 1.0 or as scheduled. Use worst case.
   b. **Component Response Modification Factor** ($R_p$): Use Table 13.6-1 in ACSE 7-05 for each component.
   c. **Component Amplification Factor** ($A_p$): Use Table 13.6-1 in ACSE 7-05 for each component.

4. **Design Spectral Response Acceleration at Short Periods (0.2 Second)** ($S_{DS}$): 0.655 per structural design notes

5. **Design Spectral Response Acceleration at 1-Second Period** ($S_{D1}$): 0.256 per structural design notes

1.05 **ACTION SUBMITTALS**:

A. Submit in accordance with SECTION 01300 – SUBMITTALS.

B. **Product Data**: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. **Interlocking Snubbers**: Include ratings for horizontal, vertical, and combined loads.

C. **Delegated-Design Submittal**: For each vibration isolation and seismic-restraint device.
   1. Include design calculations and details for selecting vibration isolators and seismic/wind restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the University responsible for their preparation. The University shall be licensed in the state that the project is located.
2. **Design Calculations:** Calculate static and dynamic loading due to equipment weight and operation, due to seismic/wind forces required to select vibration isolators, and due to seismic/wind restraints.

3. **Seismic-Restraint Details:**
   
a. **Design Analysis:** To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

   b. **Details:** Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

   d. **Preapproval and Evaluation Documentation:** By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.06 **QUALITY ASSURANCE:**

   A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

   B. **Welding:** Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

   C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by University.

**PART 2 - PRODUCTS**

2.01 **APPROVED MANUFACTURERS:**
A. Subject to compliance with requirements, provide products by one of the following or approved equal:

B. Vibro-Acoustics

2.02 VIBRATION ISOLATORS:

A. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

B. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

C. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. **Overload Capacity:** Support 200 percent of rated load, fully compressed, without deformation or failure.

6. **Elastomeric Element:** Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. **Self-centering hanger rod cap** to ensure concentricity between hanger rod and support spring coil.

8. Minimum deflection shall be as scheduled.

2.03 **RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS:**

A. **General Requirements for Restrained Vibration Isolation Roof-Curb Rails:** Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

B. **Lower Support Assembly:** Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

C. **Spring Isolators:** Adjustable, restrained spring isolators shall be mounted on 1/4-inch thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof. Minimum spring deflection shall be as scheduled.

1. **Pads:** Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

   a. **Resilient Material:** Oil- and water-resistant standard neoprene. Cork is not acceptable.

D. **Snubber Bushings:** All-directional, elastomeric snubber bushings at least 1/4 inch thick.

E. **Water Seal:** Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflushed over roof materials.

2.04 **SEISMIC-RESTRAINT DEVICES:**
A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

C. Rigid Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

F. Uplift Stopwashers: Heavy gage steel washer installed at a maximum of 1/4" below the bottom of all spring hangers to prevent seismic uplift forces from decompressing springs.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
J. **Mechanical Anchor Bolts:** Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter. Anchors bolt shall be approved for seismic/wind loading by the ICC-ES.

K. **Adhesive Anchor Bolts:** Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Anchors bolt shall be approved for seismic/wind loading by the ICC-ES.

2.05 **FACTORY FINISHES:**

A. **Finish:** Manufacturer's standard prime-coat finish ready for field painting. All products to be located outdoors shall be hot-dipped galvanized or stainless steel.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 **APPLICATIONS:**

A. **Multiple Pipe Supports:** Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. **Hanger Rod Stiffeners:** Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. **Strength of Support and Seismic-Restraint Assemblies:** Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
3.03 VIBRATION-CONTROL AND SEISMIC/WIND-RESTRAINT DEVICE INSTALLATION:

A. Comply with requirements in SECTION 07720 – ROOF ACCESSORIES for installation of roof curbs, equipment supports, and roof penetrations.

B. **Equipment Restraints:**
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators when isolators are not seismically rated. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. **Piping Restraints:**
   1. Comply with requirements in MSS SP-127.
   2. For ductile piping (i.e. steel, copper, etc.), space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.. Brace a change of direction longer than 12 feet.
   3. For non-ductile piping (i.e. cast iron, pvc, glass, etc.), space lateral supports a maximum of 20 feet o.c., and longitudinal supports a maximum of 40 feet Brace a change of direction longer than 6 feet.

D. **Duct Work Restraints:**
   1. Space lateral supports at a maximum of 30 feet o.c.
   2. Space longitudinal supports at a maximum of 60 feet o.c.
   3. Brace a change of direction longer than 8 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members. C-type clamps shall not be used to attach braces to the building structure.

J. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the University if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:
Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.05 ADJUSTING:
A. Adjust restraints to permit free movement of equipment within normal mode of operation.
3.06 INSPECTION:

A. Upon completion, arrange to have the seismic and vibration control manufacturer or representative inspect and certify that all installations comply with the applicable building code(s). Submit certification to University.

3.07 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE:

A. See schedule in plans.

END OF SECTION
SECTION 15077 - IDENTIFICATION FOR HVAC, PLUMBING AND FIRE PROTECTION PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

A. General: As specified in Section 01001.

1.02 SUMMARY:

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.
   5. Warning tags.

1.03 ACTION SUBMITTALS:

A. Submit in accordance with SECTION 01300 – SUBMITTALS.

B. Product Data: For each type of product indicated.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 COORDINATION:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:
A. Plastic Labels for Equipment:
   1. **Material and Thickness**: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. **Letter Color**: White.
   3. **Background Color**: Black.
   4. **Maximum Temperature**: Able to withstand temperatures up to 160 deg F.
   5. **Minimum Label Size**: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. **Minimum Letter Size**: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. **Fasteners**: Stainless-steel rivets or self-tapping screws.
   8. **Adhesive**: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS:

A. **Material and Thickness**: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. **Letter Color**: Black.

C. **Background Color**: Yellow.

D. **Maximum Temperature**: Able to withstand temperatures up to 160 deg F.
E. **Minimum Label Size:** Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. **Minimum Letter Size:** 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. **Fasteners:** Stainless-steel rivets or self-tapping screws.

H. **Adhesive:** Contact-type permanent adhesive, compatible with label and with substrate.

I. **Label Content:** Include caution and warning information, plus emergency notification instructions.

### 2.03 PIPE LABELS:

A. **General Requirements for Manufactured Pipe Labels:** Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. **Pretensioned Pipe Labels:** Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. **Pipe Label Contents:** Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. **Flow-Direction Arrows:** Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. **Lettering Size:** At least 1-1/2 inches.

### 2.04 VALVE TAGS:

A. **Valve Tags:** Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. **Tag Material:** Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. **Fasteners:** Brass wire-link chain.

B. **Valve Schedules:** For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.05 WARNING TAGS:

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION:

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION:

A. Piping Color-Coding: Painting of piping is specified in Division 9.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.


C. **Pipe Label Color Schedule:**

1. **Chilled-Water Piping:**
   a. **Background Color:** White.
   b. **Letter Color:** Blue.

2. **Oxygen Piping:**
   a. **Background Color:** Green.
   b. **Letter Color:** White.

3. **Vent Piping:**
   a. **Background Color:** White.
   b. **Letter Color:** Black.

4. **WAGD Piping:**
   a. **Background Color:** Black.
   b. **Letter Color:** White.

5. **Natural Gas Piping:**
   a. **Background Color:** Yellow.
   b. **Letter Color:** Black.

6. **Fire Protection Piping:**
   a. **Background Color:** Red.
   b. **Letter Color:** White.

7. **Domestic Water Piping:**
3.04 VALVE-TAG INSTALLATION:
   A. Install tags on valves and control devices in piping systems, except check
      valves; valves within factory-fabricated equipment units; shutoff valves;
      faucets; convenience and lawn-watering hose connections; and HVAC
      terminal devices and similar roughing-in connections of end-use fixtures
      and units. List tagged valves in a valve schedule.
   B. Valve-Tag Application Schedule: Tag valves according to size, shape, and
      color scheme and with captions similar to those indicated in the following
      subparagraphs:
      1. Valve-Tag Size and Shape:
         a. All Piping: 1-1/2 inches, round.
      2. Valve-Tag Color:
         a. All Piping: Natural.
      3. Letter Color:
         a. All Piping: Black.

3.05 WARNING-TAG INSTALLATION:
   A. Write required message on, and attach warning tags to, equipment and
      other items where required.

END OF SECTION
SECTION 15085 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section includes insulating the following plumbing piping services:
      1. Domestic hot-water piping.
      2. Floor Drains, Traps, and Sanitary Drain Piping Receiving Condensate and Equipment Drain Water below 60 Deg F.
   B. Related Sections:
      1. Division 15 Section "Plumbing Equipment Insulation."

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
   C. LEED Submittals:
      1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
      2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with Section 01300 - SUBMITTALS.
   B. Qualification Data: For qualified Installer.

1.05 QUALITY ASSURANCE:
A. **Installer Qualifications:** Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. **Surface-Burning Characteristics:** For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. **Insulation Installed Indoors:** Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. **Insulation Installed Outdoors:** Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. **Supply and Drain Protective Shielding Guards:** ICC A117.1.

1.06 **DELIVERY, STORAGE, AND HANDLING:**

A. **Packaging:** Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 **COORDINATION:**

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 **SCHEDULING:**

A. Schedule insulation application after pressure testing system. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

2.01 **INSULATION MATERIALS:**

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. **Flexible Elastomeric Insulation:** Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

G. **Mineral-Fiber Blanket Insulation:** Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. **Mineral-Fiber, Preformed Pipe Insulation:**
   1. **Type I, 850 Deg F Materials:** Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. **Polyolefin:** Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.

2.02 **INSULATING CEMENTS:**

A. **Mineral-Fiber Insulating Cement:** Comply with ASTM C 195.

B. **Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement:** Comply with ASTM C 449.

2.03 **ADHESIVES:**

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. **Flexible Elastomeric and Polyolefin Adhesive:** Comply with MIL-A-24179A, Type II, Class I.
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."


1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. **Vapor-Barrier Mastic**: Water based; suitable for indoor use on below-ambient services.
   1. **Water-Vapor Permeance**: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. **Service Temperature Range**: Minus 20 to plus 180 deg F.
   3. **Solids Content**: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. **Color**: White.

C. **Vapor-Barrier Mastic**: Solvent based; suitable for indoor use on below-ambient services.
   1. **Water-Vapor Permeance**: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   2. **Service Temperature Range**: 0 to 180 deg F.
   3. **Solids Content**: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   4. **Color**: White.

D. **Vapor-Barrier Mastic**: Solvent based; suitable for outdoor use on below-ambient services.
   1. **Water-Vapor Permeance**: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   2. **Service Temperature Range**: Minus 50 to plus 220 deg F.
   3. **Solids Content**: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. **Color**: White.

E. **Breather Mastic**: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. **Water-Vapor Permeance**: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   2. **Service Temperature Range**: Minus 20 to plus 180 deg F.
   3. **Solids Content**: 60 percent by volume and 66 percent by weight.
   4. **Color**: White.
2.05 **SEALANTS:**

**A. Joint Sealants:**

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. **Service Temperature Range:** Minus 100 to plus 300 deg F.
4. **Color:** White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

**B. FSK and Metal Jacket Flashing Sealants:**

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. **Service Temperature Range:** Minus 40 to plus 250 deg F.
4. **Color:** Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

**C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:**

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. **Service Temperature Range:** Minus 40 to plus 250 deg F.
4. **Color**: White.

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

### 2.06 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. **ASJ-SSL**: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

### 2.07 FIELD-APPLIED JACKETS:

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. **PVC Jacket**: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. **Adhesive**: As recommended by jacket material manufacturer.

2. **Color**: White.

3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. **Shapes**: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. **Metal Jacket**:

1. **Aluminum Jacket**: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:
   1) Same material, finish, and thickness as jacket.
   2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   3) Tee covers.
   4) Flange and union covers.
   5) End caps.
   6) Beveled collars.
   7) Valve covers.
   8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.08 TAPES:

A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.

2. Thickness: 3.7 mils.

3. Adhesion: 100 ounces force/inch in width.

4. Elongation: 5 percent.

5. Tensile Strength: 34 lbf/inch in width.

2.09 SECUREMENTS:

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.10 PROTECTIVE SHIELDING GUARDS:

A. Protective Shielding Pipe Covers:

1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
B. **Protective Shielding Piping Enclosures:**
   1. **Description:** Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**
   A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
      1. Verify that systems to be insulated have been tested and are free of defects.
      2. Verify that surfaces to be insulated are clean and dry.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **PREPARATION:**
   A. **Surface Preparation:** Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
   B. **Surface Preparation:** Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
      1. **Stainless Steel:** Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
      2. **Carbon Steel:** Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 **GENERAL INSTALLATION REQUIREMENTS:**
   A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

3.04 PENETRATIONS:

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

   1. Seal penetrations with flashing sealant.

   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. **Insulation Installation at Underground Exterior Wall Penetrations:**
   Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. **Insulation Installation at Aboveground Exterior Wall Penetrations:** Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. **Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):** Install insulation continuously through walls and partitions.

E. **Insulation Installation at Fire-Rated Wall and Partition Penetrations:** Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

F. **Insulation Installation at Floor Penetrations:**
   1. **Pipe:** Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.05 **GENERAL PIPE INSULATION INSTALLATION:**

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. **Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:**
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

TECHNICAL SPECIFICATIONS
Plumbing Piping Insulation
Project No. SW-12-6238
1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

3.08 INSTALLATION OF POLYOLEFIN INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. **Insulation Installation on Pipe Fittings and Elbows:**
   1. Install mitered sections of polyolefin pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. **Insulation Installation on Valves and Pipe Specialties:**
   1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 **FIELD-APPLIED JACKET INSTALLATION:**

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 **FINISHES:**

A. **Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material:** Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
1. **Flat Acrylic Finish:** Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   
   a. **Finish Coat Material:** Interior, flat, latex-emulsion size.

B. **Flexible Elastomeric Thermal Insulation:** After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. **Color:** Final color as selected by University. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 **PIPE INSULATION SCHEDULE, GENERAL:**

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. **Items Not Insulated:** Unless otherwise indicated, do not install insulation on the following:

   1. Underground piping except for hot water.
   
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 **INDOOR PIPING INSULATION SCHEDULE:**

A. **Domestic Hot and Recirculated Hot Water:**

   1. Insulation shall be one of the following:

      a. **Mineral-Fiber, Preformed Pipe Insulation, Type I:** 1 inch thick.
      
      b. **Polyolefin:** 1 inch thick.

B. **Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:**

   1. **All Pipe Sizes:** Insulation shall be the following:

      a. Provide pre-manufactured pipe shield.

C. **Floor Drains, Traps, and Sanitary Drain Piping Receiving Condensate and Equipment Drain Water below 60 Deg F:**

   1. **All Pipe Sizes:** Insulation shall be the following:
a. Flexible Elastomeric: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE:

A. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inches thick.
   b. Polyolefin: 1 inches thick.

3.14 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE:

A. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

   1. Painted Aluminum, Stucco Embossed: 0.032 inch thick.
   2. Stainless Steel, Type 304, Stucco Embossed: 0.020 inch thick.

3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET:

A. For underground direct-buried piping applications, install underground PVC direct-buried jacket over insulation material.

END OF SECTION
SECTION 15086 - DUCT INSULATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.
   B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Section includes insulating the following duct services:
      1. Indoor, supply air.

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Qualification Data: For qualified Installer.

1.05 QUALITY ASSURANCE:
   A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
   B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
      1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
      2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
1.06 DELIVERY, STORAGE, AND HANDLING:

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 SCHEDULING:

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:


B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 FIRE-RATED INSULATION SYSTEMS:
A. **Fire-Rated Blanket**: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.03 **ADHESIVES**:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. **Mineral-Fiber Adhesive**: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. **ASJ Adhesive, and FSK Jacket Adhesive**: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 **MASTICS**:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. **Vapor-Barrier Mastic**: Water based; suitable for indoor use on below ambient services.

1. **Water-Vapor Permeance**: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. **Service Temperature Range**: Minus 20 to plus 180 deg F.

3. **Solids Content**: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. **Color**: White.

### 2.05 LAGGING ADHESIVES:

A. **Description**: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.

3. **Service Temperature Range**: 0 to plus 180 deg F.

4. **Color**: White.

### 2.06 SEALANTS:

A. **FSK and Metal Jacket Flashing Sealants**:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. **Service Temperature Range**: Minus 40 to plus 250 deg F.

4. **Color**: Aluminum.

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

### 2.07 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. **FSK Jacket**: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing, complying with ASTM C 1136, Type II.
2.08 FIELD-APPLIED FABRIC-REINFORCING MESH:
   A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.
   B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

2.09 FIELD-APPLIED CLOTHS:
   A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. .

2.10 TAPES:
   A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
      1. Width: 3 inches .
      2. Thickness: 6.5 mils .
      4. Elongation: 2 percent.
      5. Tensile Strength: 40 lbf/inch in width.
      6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
   B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
      1. Width: 2 inches .
      2. Thickness: 3.7 mils .
      3. Adhesion: 100 ounces force/inch in width.
      4. Elongation: 5 percent.
      5. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS:
   A. Bands:
      1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
2. **Aluminum**: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. **Insulation Pins and Hangers**:

1. **Cupped-Head, Capacitor-Discharge-Weld Pins**: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

2. **Metal, Adhesively Attached, Perforated-Base Insulation Hangers**: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. **Baseplate**: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. **Spindle**: Aluminum or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. **Adhesive**: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. **Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers**: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. **Baseplate**: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   b. **Spindle**: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   c. **Adhesive**: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. **Self-Sticking-Base Insulation Hangers:** Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. **Baseplate:** Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. **Spindle:** Aluminum or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.

5. **Insulation-Retaining Washers:** Self-locking washers formed from 0.016-inch-thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

6. **Nonmetal Insulation-Retaining Washers:** Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   C. **Staples:** Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.12 **CORNER ANGLES:**
   A. **Aluminum Corner Angles:** 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
   B. **Stainless-Steel Corner Angles:** 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.02 PREPARATION:

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS:

A. **Insulation Installation at Roof Penetrations:** Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. **Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):** Install insulation continuously through walls and partitions.

3.05 INSTALLATION OF MINERAL-FIBER INSULATION:

A. **Blanket Insulation Installation on Ducts and Plenums:** Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.06 FINISHES:

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.


B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by University. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.07 DUCT INSULATION SCHEDULE, GENERAL:

A. Plenums and Ducts Requiring Insulation:

   1. Indoor, supply air.

B. Items Not Insulated:

   1. Factory-insulated flexible ducts.

3.08 INDOOR DUCT AND PLENUM INSULATION SCHEDULE:

A. Supply-air duct insulation shall be the following:

   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
SECTION 15088 - HVAC PIPING INSULATION

PART 1 - GENERAL:

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section includes insulating the following HVAC piping systems:
      1. Condensate drain piping, indoors and outdoors.
      2. Chilled-water and brine piping, indoors and outdoors.

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with Section 01300 - SUBMITTALS.
   B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with Section 01300 - SUBMITTALS.
   B. Qualification Data: For qualified Installer.

1.05 QUALITY ASSURANCE:
   A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
   B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
      1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
      2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
1.06 DELIVERY, STORAGE, AND HANDLING:

A. **Packaging:** Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 SCHEDULING:

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:


B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. **Cellular Glass:** Inorganic, combustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. **Block Insulation:** ASTM C 552, Type I.

2. **Special-Shaped Insulation:** ASTM C 552, Type III.

3. **Board Insulation:** ASTM C 552, Type IV.

4. **Preformed Pipe Insulation with Factory-Applied ASJ-SSL:** Comply with ASTM C 552, Type II, Class 2.

5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. **Flexible Elastomeric Insulation:** Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

2.02 **ADHESIVES:**

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. **Cellular-Glass Adhesive:** Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. **Flexible Elastomeric and Polyolefin Adhesive:** Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. **ASJ Adhesive, and FSK and PVDC Jacket Adhesive:** Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastic that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

2.04 LAGGING ADHESIVES:

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
   3. Service Temperature Range: 0 to plus 180 deg F.

2.05 SEALANTS:

A. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
3. **Service Temperature Range:** Minus 40 to plus 250 deg F.

4. **Color:** Aluminum.

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. **ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:**

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. **Service Temperature Range:** Minus 40 to plus 250 deg F.

4. **Color:** White.

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 **FACTORY-APPLIED JACKETS:**

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. **ASJ-SSL:** ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.07 **FIELD-APPLIED FABRIC-REINFORCING MESH:**

A. **Woven Glass-Fiber Fabric:** Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

B. **Woven Polyester Fabric:** Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
2.08 **FIELD-APPLIED CLOTHS:**

A. **Woven Glass-Fiber Fabric:** Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.09 **FIELD-APPLIED JACKETS:**

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. **FSK Jacket:** Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. **Metal Jacket:**

1. **Aluminum Jacket:** Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. **Moisture Barrier for Indoor Applications:** 3-mil-thick, heat-bonded polyethylene and kraft paper.
   d. **Factory-Fabricated Fitting Covers:**
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. **Self-Adhesive Outdoor Jacket:** 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with white or stucco-embossed aluminum-foil facing.
2.10 TAPES:
   A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
      1. **Width:** 2 inches.
      2. **Thickness:** 3.7 mils.
      3. **Adhesion:** 100 ounces force/inch in width.
      4. **Elongation:** 5 percent.
      5. **Tensile Strength:** 34 lbf/inch in width.

2.11 SECUREMENTS:
   A. Bands:
      1. **Stainless Steel:** ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
      2. **Aluminum:** ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
      3. **Springs:** Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
   
   B. **Staples:** Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
      1. Verify that systems to be insulated have been tested and are free of defects.
      2. Verify that surfaces to be insulated are clean and dry.
      3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
   A. **Surface Preparation:** Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use de-mineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
K. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

L. **Install insulation with factory-applied jackets as follows:**
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer’s written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 **PENETRATIONS:**

A. **Insulation Installation at Roof Penetrations:** Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.
B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.05 GENERAL PIPE INSULATION INSTALLATION:

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
3.06 INSTALLATION OF CELLULAR-GLASS INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3.08 FIELD-APPLIED JACKET INSTALLATION:
   A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.09 FINISHES:
   A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
      1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
   C. Color: Final color as selected by University. Vary first and second coats to allow visual inspection of the completed Work.
   D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL:
   A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.11 INDOOR PIPING INSULATION SCHEDULE:
   A. Condensate and Equipment Drain Water below 60 Deg F:
      1. All Pipe Sizes: Insulation shall be the following:
         a. Flexible Elastomeric: 3/4 inch thick.
   B. Chilled Water and Brine, above 40 Deg F:
      1. NPS 2 and Smaller: Insulation shall be the following:
         a. Flexible Elastomeric: 1 inch thick.
      2. NPS 2-1/2 and larger: Insulation shall be the following:
a. **Cellular Glass**: 2 inches thick.

3.12 **OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE:**

A. **Chilled Water and Brine:**

1. **Insulation shall be the following:**
   
a. **Flexible Elastomeric (NPS 2” and smaller)**: 1-1/2 thick.
   
b. **Cellular Glass (NPS 2-1/2” to 14”)**: 2 inches thick.

3.13 **OUTDOOR, FIELD-APPLIED JACKET SCHEDULE:**

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor’s option.

C. **Piping, Exposed:**

1. Painted Aluminum, Corrugated or Stucco Embossed with Z-Shaped Locking Seam: 0.040 inch thick.

END OF SECTION
SECTION 15093 - SLEEVES AND SLEEVE SEALS FOR PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes the following for Plumbing, HVAC and Fire Sprinkler piping:
   1. Sleeves.
   2. Sleeve-seal fittings.

1.03 ACTION SUBMITTALS:
A. Submit in accordance with SECTION 01300 – SUBMITTALS.
B. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES:
A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.02 SLEEVE-SEAL FITTINGS:
A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.03 GROUT:
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. **Packaging:** Premixed and factory packaged.

**PART 3 - EXECUTION**

**3.01 SLEEVE INSTALLATION:**

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. **Exception:** Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in SECTION 07900 – JOINT SEALERS.

D. **Fire-BARRIER Penetrations:** Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

**3.02 SLEEVE-SEAL-FITTING INSTALLATION:**

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.
3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE:

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.

2. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

3. Interior Partitions:

END OF SECTION
SECTION 15096 - ESCUTCHEONS FOR PLUMBING, HVAC AND FIRE PROTECTION PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Escutcheons.
      2. Floor plates.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS:
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
   D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
   E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.02 FLOOR PLATES:
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION:
   A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   
   1. **Escutcheons for New Piping:**
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   
   2. **Escutcheons for Existing Piping:**
      a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      b. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
      c. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
      d. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
   
C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   
   1. **New Piping:** One-piece, floor-plate type.
   
   2. **Existing Piping:** Split-casting, floor-plate type.

### 3.02 FIELD QUALITY CONTROL:

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION
SECTION 15111 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Bronze angle valves.
      2. Bronze ball valves.

1.03 DEFINITIONS:
   A. CWP: Cold working pressure.
   B. EPDM: Ethylene propylene copolymer rubber.
   C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
   D. NRS: Nonrising stem.
   E. OS&Y: Outside screw and yoke.
   F. RS: Rising stem.
   G. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of valve indicated.

1.05 QUALITY ASSURANCE:
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   B. ASME Compliance:
      1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
      2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES:

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. **Ball Valves:** With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. **Valve-End Connections:**

1. **Flanged:** With flanges according to ASME B16.1 for iron valves.
2. **Grooved:** With grooves according to AWWA C606.
3. **Solder Joint:** With sockets according to ASME B16.18.
4. **Threaded:** With threads according to ASME B1.20.1.

G. **Valve Bypass and Drain Connections:** MSS SP-45.

2.02 **BRONZE ANGLE VALVES:**

A. **Class 150, Bronze Angle Valves with Bronze Disc:**

1. **Description:**
   a. **Standard:** MSS SP-80, Type 1.
   b. **CWP Rating:** 300 psig.
   c. **Body Material:** ASTM B 62, bronze with integral seat and union-ring bonnet.
   d. **Ends:** Threaded.
   e. **Stem and Disc:** Bronze.
   f. **Packing:** Asbestos free.
   g. **Handwheel:** Malleable iron, bronze, or aluminum.

2.03 **BRONZE BALL VALVES:**

A. **Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:**

1. **Description:**
   a. **Standard:** MSS SP-110.
   b. **SWP Rating:** 150 psig.
   c. **CWP Rating:** 600 psig.
   d. **Body Design:** Two piece.
   e. **Body Material:** Bronze.
f. **Ends**: Threaded.

g. **Seats**: PTFE or TFE.

h. **Stem**: Bronze.

i. **Ball**: Chrome-plated brass.

j. **Port**: Full.

2.04 **BRONZE SWING CHECK VALVES**:

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. **Description**:

   a. **Standard**: MSS SP-80, Type 3.

   b. **CWP Rating**: 300 psig.

   c. **Body Design**: Horizontal flow.

   d. **Body Material**: ASTM B 62, bronze.

   e. **Ends**: Threaded.

   f. **Disc**: Bronze.

**PART 3 - EXECUTION**

3.01 **EXAMINATION**:

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.
3.02 VALVE INSTALLATION:
   A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
   B. Locate valves for easy access and provide separate support where necessary.
   C. Install valves in horizontal piping with stem at or above center of pipe.
   D. Install valves in position to allow full stem movement.
   E. Install check valves for proper direction of flow and as follows:
      1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 ADJUSTING:
   A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:
   A. If valve applications are not indicated, use the following:
      1. Shutoff Service: Ball, butterfly valves.
      3. Throttling Service: Globe or angle or ball valves.
      4. Pump-Discharge Check Valves:
         a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
   C. Select valves, except wafer types, with the following end connections:
      1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
      2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
      3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. **For Steel Piping, NPS 2-1/2 to NPS 4:** Flanged ends except where threaded valve-end option is indicated in valve schedules below.

5. **For Grooved-End Copper Tubing and Steel Piping:** Valve ends may be grooved.

**3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE:**

A. **Pipe NPS 2 and Smaller**:
   1. **Bronze Angle Valves:** Class 125, bronze disc.
   2. **Ball Valves:** Two piece, full port, bronze with bronze trim.
   3. **Bronze Swing Check Valves:** Class 125, bronze disc.

B. **Pipe NPS 2-1/2 and Larger**:
   1. **Iron, Single-Flange Butterfly Valves:** 200 CWP, EPDM seat, stainless-steel disc.
   2. **Iron, Grooved-End Butterfly Valves:** 175 CWP.
   3. **Iron Swing Check Valves:** Class 125, metal seats.
   4. **Iron Swing Check Valves with Closure Control:** Class 125, lever and spring.
   5. **Iron, Grooved-End Swing Check Valves:** 300 CWP.

**END OF SECTION**
SECTION 15112 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 GENERAL:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Bronze ball valves.
      2. Iron, single-flange butterfly valves.
      4. Iron swing check valves.

1.03 DEFINITIONS:
   A. CWP: Cold working pressure.
   B. EPDM: Ethylene propylene copolymer rubber.
   C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
   D. NRS: Nonrising stem.
   E. OS&Y: Outside screw and yoke.
   F. RS: Rising stem.
   G. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of valve indicated.

1.05 QUALITY ASSURANCE:
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   B. ASME Compliance:
      1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES:

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller.
E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES:

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.
2.03 **IRON, SINGLE-FLANGE BUTTERFLY VALVES:**

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. **Description:**
   
   a. **Standard**: MSS SP-67, Type I.
   
   b. **CWP Rating**: 200 psig.
   
   c. **Body Design**: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   
   d. **Body Material**: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   
   e. **Seat**: EPDM.
   
   f. **Stem**: One- or two-piece stainless steel.
   
   g. **Disc**: Stainless steel.

2.04 **BRONZE SWING CHECK VALVES:**

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. **Description:**
   
   a. **Standard**: MSS SP-80, Type 3.
   
   b. **CWP Rating**: 300 psig.
   
   c. **Body Design**: Horizontal flow.
   
   d. **Body Material**: ASTM B 62, bronze.
   
   e. **Ends**: Threaded.
   
   f. **Disc**: Bronze.

2.05 **IRON SWING CHECK VALVES:**

A. Class 250, Iron Swing Check Valves with Metal Seats:

1. **Description:**
   
   a. **Standard**: MSS SP-71, Type I.
   
   b. **NPS 2-1/2 to NPS 12, CWP Rating**: 500 psig.
   
   c. **Body Design**: Clear or full waterway.
d. **Body Material:** ASTM A 126, gray iron with bolted bonnet.

e. **Ends:** Flanged.

f. **Trim:** Bronze.

g. **Gasket:** Asbestos free.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 **VALVE INSTALLATION:**

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

   1. **Swing Check Valves:** In horizontal position with hinge pin level.
3.03 **ADJUSTING:**

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 **GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:**

A. If valve applications are not indicated, use the following:

1. **Shutoff Service:** Ball, butterfly, or gate valves.

2. **Butterfly Valve Dead-End Service:** Single-flange (lug) type.

3. **Throttling Service except Steam:** Ball, or butterfly valves.

4. **Pump-Discharge Check Valves:**
   
a. **NPS 2 and Smaller:** Bronze swing check valves with bronze disc.

   b. **NPS 2-1/2 and Larger:** Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. **For Copper Tubing, NPS 2 and Smaller:** Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. **For Copper Tubing, NPS 2-1/2 to NPS 4:** Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. **For Steel Piping, NPS 2-1/2 to NPS 4:** Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.05 **CHILLED AND CONDENSER-WATER VALVE SCHEDULE:**

A. **Pipe NPS 2 and Smaller:**

1. **Ball Valves:** Two piece, full port, bronze with stainless-steel trim.

2. **Bronze Swing Check Valves:** Class 150, bronze disc.

B. **Pipe NPS 2-1/2 and Larger:**
1. **Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12:** 200 CWP, EPDM seat, stainless-steel disc.

2. **Iron Swing Check Valves:** Class 250, metal seats.

3. **Iron, Grooved-End Check Valves, NPS 3 to NPS 12:** 300 CWP.

4. **Iron Gate Valves:** Class 250, NRS.

END OF SECTION
SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.
   B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Section Includes:
      1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
      2. Encasement for piping.
   B. Related Requirements:
      1. Division 2 Section "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For transition fittings and dielectric fittings.
   C. Shop Drawings: Detail, at 1/4 scale, the piping layout with coordination with other disciplines.

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. System purging and disinfecting activities report.
   C. Field quality-control reports.

1.05 FIELD CONDITIONS:
   A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
1. Notify University no fewer than two days in advance of proposed interruption of water service.

2. Do not interrupt water service without University’s written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.02 COPPER TUBE AND FITTINGS:

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.


D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:
   1. MSS SP-123.
   4. Solder-joint or threaded ends.

F. Copper-Tube, Extruded-Tee Connections:
   1. Description: Tee formed in copper tube according to ASTM F 2014.

G. Appurtenances for Grooved-End Copper Tubing:
   1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.
   2. Mechanical Couplings for Grooved-End Copper Tubing:
      a. Copper-tube dimensions and design similar to AWWA C606.
      b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.

d. Bolts and nuts.

e. Minimum Pressure Rating: 300 psig.

2.03 DUCTILE-IRON PIPE AND FITTINGS:

A. Mechanical-Joint, Ductile-Iron Pipe:
   1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:
   1. AWWA C153/A21.53, ductile iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.04 PIPING JOINING MATERIALS:

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
2.05 ENCASEMENT FOR PIPING:
   A. **Standard**: ASTM A 674 or AWWA C105/A21.5.
   B. **Form**: tube.

2.06 TRANSITION FITTINGS:
   A. **General Requirements**:
      1. Same size as pipes to be joined.
      2. Pressure rating at least equal to pipes to be joined.
      3. End connections compatible with pipes to be joined.
   B. **Fitting-Type Transition Couplings**: Manufactured piping coupling or specified piping system fitting.
   C. **Sleeve-Type Transition Coupling**: AWWA C219.

2.07 DIELECTRIC FITTINGS:
   A. **General Requirements**: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   B. **Dielectric Unions**:
      1. **Standard**: ASSE 1079.
      2. **Pressure Rating**: 125 psig minimum at 180 deg F.
      3. **End Connections**: Solder-joint copper alloy and threaded ferrous.
   C. **Dielectric Flanges**:
      1. **Standard**: ASSE 1079.
      2. Factory-fabricated, bolted, companion-flange assembly.
      3. **Pressure Rating**: 125 psig minimum at 180 deg F.
      4. **End Connections**: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
   D. **Dielectric-Flange Insulating Kits**:
      1. Nonconducting materials for field assembly of companion flanges.
      2. **Pressure Rating**: 150 psig.
      3. **Gasket**: Neoprene or phenolic.
4. **Bolt Sleeves**: Phenolic or polyethylene.

5. **Washers**: Phenolic with steel backing washers.

**E. Dielectric Nipples:**

1. **Standard**: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. **Pressure Rating and Temperature**: 300 psig at 225 deg F.
4. **End Connections**: Male threaded or grooved.
5. **Lining**: Inert and noncorrosive, propylene.

**PART 3 - EXECUTION**

3.01 **EARTHWORK:**

A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.02 **PIPING INSTALLATION:**

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 15 Section "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Division 15 Section "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.
G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Division 15 Section "Domestic Water Piping Specialties."

H. Install domestic water piping level and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company’s requirements.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump.

T. Install thermostats in hot-water circulation piping.

U. Install thermometers on outlet piping from each water heater.

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

X. Install escutcheons for piping penetrations of walls, ceilings, and floors.
3.03 JOINT CONSTRUCTION:

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION:

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.05 DIELECTRIC FITTING INSTALLATION:
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, nipples or unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.06 HANGER AND SUPPORT INSTALLATION:
A. Comply with requirements for seismic-restraint devices in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
B. Comply with requirements for pipe hanger, support products, and installation in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment."
   1. **Vertical Piping**: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. **100 Feet and Less**: MSS Type 1, adjustable, steel clevis hangers.
      b. **Longer Than 100 Feet**: MSS Type 43, adjustable roller hangers.
      c. **Longer Than 100 Feet if Indicated**: MSS Type 49, spring cushion rolls.
   3. **Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer**: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. **Base of Vertical Piping**: MSS Type 52, spring hangers.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. **NPS 3/4 and Smaller**: 60 inches with 3/8-inch rod.
   2. **NPS 1 and NPS 1-1/4**: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer’s written instructions.

3.07 CONNECTIONS:
A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code. Comply with requirements for connection sizes in Division 15 plumbing fixture Sections.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.08 IDENTIFICATION:

A. Identify system components per identification specification section.

B. Label pressure piping with system operating pressure.

3.09 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) **Roughing-in Inspection**: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) **Final Inspection**: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. **Reinspection**: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

d. **Reports**: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. **Piping Tests**:

   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

   d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

   f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.
3.10 **ADJUSTING:**

A. **Perform the following adjustments before operation:**

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 **CLEANING:**

A. **Clean and disinfect potable domestic water piping as follows:**

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. **Fill and isolate system according to either of the following:**
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Repeat procedures if biological examination shows contamination.

e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

   b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE:

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:

   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:

1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.

F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

G. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.

END OF SECTION
SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Vacuum breakers.
      2. Backflow preventers.
      5. Hose bibbs.
      6. Trap-seal primer valves.
      7. Trap-seal primer systems.

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of product.
   C. Shop Drawings: For domestic water piping specialties.
      1. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES:
   A. Potable-water piping and components shall comply with NSF 6 and NSF 14.

2.02 PERFORMANCE REQUIREMENTS:
   A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 VACUUM BREAKERS:
   A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
      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. FEBCO; a division of Watts Water Technologies, Inc.
         b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
         c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
      3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
      5. Inlet and Outlet Connections: Threaded.

2.04 BACKFLOW PREVENTERS:
   A. Reduced-Pressure-Principle Backflow Preventers:
      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. FEBCO; a division of Watts Water Technologies, Inc.
         b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. **Standard:** ASSE 1013.

3. **Operation:** Continuous-pressure applications.

4. **Pressure Loss:** 12 psig maximum, through middle third of flow range.

5. **Body:** Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.

6. **End Connections:** Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

7. **Configuration:** Designed for horizontal, straight-through flow.

8. **Accessories:**
   a. **Valves NPS 2 and Smaller:** Ball type with threaded ends on inlet and outlet.
   b. **Valves NPS 2-1/2 and Larger:** Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   c. **Air-Gap Fitting:** ASME A112.1.2, matching backflow-preventer connection.

B. **Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:**

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. **Cash Acme:** a division of Reliance Worldwide Corporation.
   b. **Lancer Corporation.**
   c. **Watts:** a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. **Standard:** ASSE 1032.

3. **Operation:** Continuous-pressure applications.

4. **Size:** NPS 1/4 or NPS 3/8.

5. **Body:** Stainless steel.

6. **End Connections:** Threaded.
C. **Double-Check, Detector-Assembly Backflow Preventers:**

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. FEBCO; a division of Watts Water Technologies, Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. **Standard:** ASSE 1048 and is FM Global approved or UL listed.

3. **Operation:** Continuous-pressure applications.

4. **Pressure Loss:** 5 psig maximum, through middle third of flow range.

5. **Body:** Cast iron with interior lining that complies with AWWA C550 or that is FDA approved.

6. **End Connections:** Flanged.

7. **Configuration:** Designed for horizontal, straight-through flow.

8. **Accessories:**
   a. **Valves:** Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   b. **Bypass:** With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. **Backflow-Preventer Test Kits:**

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. FEBCO; a division of Watts Water Technologies, Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. **Description:** Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.
2.05 **WATER PRESSURE-REDUCING VALVES:**

A. **Water Regulators:**

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. Honeywell International Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. **Standard:** ASSE 1003.

3. **Pressure Rating:** Initial working pressure of 150 psig.

4. **Body:** Bronzefor NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.

5. **Valves for Booster Heater Water Supply:** Include integral bypass.

6. **End Connections:** Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.06 **BALANCING VALVES:**

A. **Copper-Alloy Calibrated Balancing Valves:**

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. ITT Corporation; Bell & Gossett Div.
   b. NIBCO Inc.
   c. TACO Incorporated.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. **Type:** Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.

3. **Body:** Bronze.

4. **Size:** Same as connected piping, but not larger than NPS 2.
5. **Accessories:** Meter hoses, fittings, valves, differential pressure meter, and carrying case.

6. **Accessories:** Meter hoses, fittings, valves, differential pressure meter, and carrying case.

### 2.07 OUTLET BOXES:

**A. Clothes Washer Outlet Boxes:**

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. Guy Gray Manufacturing Co., Inc.
   
   b. IPS Corporation.
   
   c. LSP Products Group, Inc.
   
   d. Oatey.
   
   e. Symmons Industries, Inc.
   
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   
   g. Whitehall Manufacturing; a div. of Acorn Engineering Company.
   
   h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. **Mounting:** Recessed.

3. **Material and Finish:** Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.

4. **Faucet:** Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.

5. **Supply Shutoff Fittings:** NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.

6. **Drain:** NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

7. **Inlet Hoses:** Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. **Drain Hose:** One 48-inch-long, rubber household clothes washer drain hose with hooked end.

2.08 **HOSE BIBBS:**

A. **Hose Bibbs**:

1. **Standard:** ASME A112.18.1 for sediment faucets.
2. **Body Material:** Bronze.
3. **Seat:** Bronze, replaceable.
4. **Supply Connections:** NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. **Outlet Connection:** Garden-hose thread complying with ASME B1.20.7.
6. **Pressure Rating:** 125 psig.
7. **Vacuum Breaker:** Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. **Finish for Equipment Rooms:** Rough bronze, or chrome or nickel plated.
9. **Finish for Service Areas:** Rough bronze.
10. **Finish for Finished Rooms:** Chrome or nickel plated.
11. **Operation for Equipment Rooms:** Wheel handle or operating key.
12. **Operation for Service Areas:** Operating key.
13. **Operation for Finished Rooms:** Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.09 **TRAP-SEAL PRIMER DEVICE:**

A. **Supply-Type, Trap-Seal Primer Device**:

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. Sioux Chief Manufacturing Company, Inc.
c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. **Standard**: ASSE 1018.

3. **Pressure Rating**: 125 psig minimum.

4. **Body**: Bronze.

5. **Inlet and Outlet Connections**: NPS 1/2 threaded, union, or solder joint.

6. **Gravity Drain Outlet Connection**: NPS 1/2 threaded or solder joint.

7. **Finish**: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. **Drainage-Type, Trap-Seal Primer Device**:

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:
   

2. **Standard**: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.

3. **Size**: NPS 1-1/4 minimum.

4. **Material**: Chrome-plated, cast brass.

2.10 **TRAP-SEAL PRIMER SYSTEMS**:

A. **Trap-Seal Primer Systems**:

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. Precision Plumbing Products, Inc.

2. **Standard**: ASSE 1044.

3. **Piping**: NPS 3/4, ASTM B 88, Type L; copper, water tubing.

4. **Cabinet**: Recessed-mounted steel box with stainless-steel cover.

5. **Electric Controls**: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
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.


7. Number Outlets: Four, Six or Eight.


PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve and pump.

E. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 6 Section "Rough Carpentry."

F. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

G. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
H. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

I. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.02 CONNECTIONS:

A. Comply with requirements for piping specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for ground equipment in DIVISION 16 SECTION 16060 – GROUNDING AND BONDING.

C. Fire-retardant-treated-wood blocking is specified in DIVISION 16 SECTION 16120 – CONDUCTORS AND CABLES for electrical connections.

3.03 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections:

1. Test each reduced-pressure-principle backflow preventer and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device’s reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 ADJUSTING:

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

END OF SECTION
SECTION 15150 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.
   B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Section Includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.
      3. Encasement for underground metal piping.

1.03 PERFORMANCE REQUIREMENTS:
   A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of product indicated.
   C. Shop Drawings: Detail, at 1/4 scale, the piping layout with coordination with other disciplines.

1.05 QUALITY ASSURANCE:
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
1.06 PROJECT CONDITIONS:

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify University no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without University’s written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS:

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:


2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 PVC PIPE AND FITTINGS:

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 SPECIALTY PIPE FITTINGS:

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      c. Sleeve Materials:
         2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Nonpressure Transition Couplings:
      b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. **Pressure Transition Couplings:**
   a. **Standard:** AWWA C219.
   b. **Description:** Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   c. **Center-Sleeve Material:** Manufacturer's standard.
   d. **Gasket Material:** Natural or synthetic rubber.
   e. **Metal Component Finish:** Corrosion-resistant coating or material.

B. **Dielectric Fittings:**
1. **General Requirements:** Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. **Dielectric Unions:**
   a. **Description:**
      1) **Standard:** ASSE 1079.
      2) **Pressure Rating:** 125 psig minimum at 180 deg F.
      3) **End Connections:** Solder-joint copper alloy and threaded ferrous.

3. **Dielectric Flanges:**
   a. **Description:**
      1) **Standard:** ASSE 1079.
      2) **Pressure Rating:** 125 psig minimum at 180 deg F.
      3) **End Connections:** Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. **Dielectric-Flange Insulating Kits:**
   a. **Description:**
      1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:
   a. Description:
      1) Standard: IAPMO PS 66
      2) Electroplated steel nipple.
      3) Pressure Rating: 300 psig at 225 deg F.
      4) End Connections: Male threaded or grooved.
      5) Lining: Inert and noncorrosive, propylene.

2.05 ENCASEMENT FOR UNDERGROUND METAL PIPING:
   A. Standard: ASTM A 674 or AWWA C105/A 21.5.
   B. Material: Linear low-density polyethylene film of 0.008-inch minimum thickness.
   C. Form: Sheet or tube.
   D. Color: Black or natural.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION:
   A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
   B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
   D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Install seismic restraints on piping.
K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
O. Install underground PVC piping according to ASTM D 2321.
P. Install engineered soil and waste drainage and vent piping systems as follows:

1. **Combination Waste and Vent**: Comply with standards of authorities having jurisdiction.
2. **Sovent Drainage System**: Comply with ASSE 1043 and sovent fitting manufacturer’s written installation instructions.
3. **Reduced-Size Venting**: Comply with standards of authorities having jurisdiction.

Q. **Plumbing Specialties**:

1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in SECTION 15155 – SANITARY WASTE PIPING SPECIALTIES.
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in SECTION 15155 – SANITARY WASTE PIPING SPECIALTIES.
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in SECTION 15155 – SANITARY WASTE PIPING SPECIALTIES.

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.02 **JOINT CONSTRUCTION**:


B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. **Threaded Joints**: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. **Damaged Threads**: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. **Grooved Joints**: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

E. **Flanged Joints**: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

F. **Plastic, Nonpressure-Piping, Solvent-Cement Joints**: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. **PVC Piping**: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.03 **SPECIALTY PIPE FITTING INSTALLATION**:

A. **Transition Couplings**:
   1. Install transition couplings at joints of piping with small differences in OD’s.
   2. **In Drainage Piping**: Unshielded Shielded, nonpressure transition couplings.

B. **Dielectric Fittings**:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   2. **Dielectric Fittings for NPS 2 and Smaller**: Use dielectric nipples or unions.
   3. **Dielectric Fittings for NPS 2-1/2 to NPS 4**: Use dielectric flanges, flange kits or nipples.
   4. **Dielectric Fittings for NPS 5 and Larger**: Use dielectric flange kits.

3.04 **VALVE INSTALLATION**:

A. General valve installation requirements are specified in SECTION 15111 – GENERAL DUTY VALVES FOR PLUMBING PIPING.
B. **Shutoff Valves:**

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. **Check Valves:** Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. **Backwater Valves:** Install backwater valves in piping subject to backflow.

1. **Horizontal Piping:** Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. **Floor Drains:** Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in SECTION 15155 – SANITARY WASTE PIPING SPECIALTIES.

3.05 **HANGER AND SUPPORT INSTALLATION:**

A. Comply with requirements for seismic-restraint devices.

B. Comply with requirements for pipe hanger and support devices.

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. **Vertical Piping:** MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

   a. **100 Feet and Less:** MSS Type 1, adjustable, steel clevis hangers.

   b. **Longer Than 100 Feet:** MSS Type 43, adjustable roller hangers.
c. **Longer Than 100 Feet if Indicated:** MSS Type 49, spring cushion rolls.

7. **Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer:** MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. **Base of Vertical Piping:** MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. **NPS 1-1/2 and NPS 2:** 60 inches with 3/8-inch rod.
   2. **NPS 3:** 60 inches with 1/2-inch rod.
   3. **NPS 4 and NPS 5:** 60 inches with 5/8-inch rod.
   4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. **NPS 1-1/4:** 84 inches with 3/8-inch rod.
   2. **NPS 1-1/2:** 108 inches with 3/8-inch rod.
   3. **NPS 2:** 10 feet with 3/8-inch rod.
   4. **NPS 2-1/2:** 11 feet with 1/2-inch rod.
   5. **NPS 3:** 12 feet with 1/2-inch rod.
   6. **NPS 4 and NPS 5:** 12 feet with 5/8-inch rod.

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. **NPS 1-1/2 and NPS 2:** 48 inches with 3/8-inch rod.
   2. **NPS 3:** 48 inches with 1/2-inch rod.
   3. **NPS 4 and NPS 5:** 48 inches with 5/8-inch rod.
J. Install supports for vertical PVC piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer’s written instructions.

3.06 CONNECTIONS:

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

   1. **Plumbing Fixtures**: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

   2. **Plumbing Fixtures and Equipment**: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

   3. **Plumbing Specialties**: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

   5. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.

   6. Comply with requirements for backwater valves cleanouts and drains specified in SECTION 15155 – SANITARY WASTE PIPING SPECIALTIES.

   7. **Equipment**: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION:

A. Identify exposed sanitary waste and vent piping.
3.08 PIPING SCHEDULE:

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Aboveground, vent piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

D. Underground, soil, waste, and vent piping shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION
SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Backwater valves.
      2. Cleanouts.
      3. Floor drains.
      4. Trench drains.
      5. Miscellaneous sanitary drainage piping specialties.

1.03 DEFINITIONS:
   A. PVC: Polyvinyl chloride plastic.

1.04 CLOSEOUT SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE:
   A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
   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.

1.06 COORDINATION:
   A. Coordinate size and location of roof penetrations.
PART 2 - PRODUCTS

2.01 BACKWATER VALVES:

A. Horizontal, Cast-Iron Backwater Valves:

2. **Size**: Same as connected piping.
3. **Body**: Cast iron.
4. **Cover**: Cast iron with bolted or threaded access check valve.
5. **End Connections**: Hubless.
6. **Type Check Valve**: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
7. **Extension**: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. **Size**: Same as floor drain outlet.
2. **Body**: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
3. **Check Valve**: Removable ball float.
4. **Inlet**: Threaded.
5. **Outlet**: Threaded or spigot.

2.02 CLEANOUTS:

A. Exposed Metal Cleanouts:

1. **Standard**: ASME A112.36.2M for cast iron for cleanout test tee.
2. **Size**: Same as connected drainage piping
3. **Body Material**: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. **Closure**: Countersunk or raised-head, cast-iron plug.
5. **Closure Plug Size**: Same as or not more than one size smaller than cleanout size.
6. **Closure**: Stainless-steel plug with seal.

B. **Metal Floor Cleanouts**:

1. **Standard**: ASME A112.36.2M for threaded, adjustable housing cleanout.
2. **Size**: Same as connected branch.
3. **Type**: Threaded, adjustable housing.
4. **Body or Ferrule**: Cast iron.
5. **Clamping Device**: Not required.
6. **Outlet Connection**: Inside calk or threaded.
7. **Closure**: Cast-iron plug.
8. **Adjustable Housing Material**: Cast iron with threads.
9. **Frame and Cover Material and Finish**: Rough bronze.
10. **Frame and Cover Shape**: Round.
11. **Top Loading Classification**: Extra Heavy Duty.
12. **Riser**: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. **Cast-Iron Wall Cleanouts**:

1. **Standard**: ASME A112.36.2M. Include wall access.
2. **Size**: Same as connected drainage piping.
3. **Body**: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. **Closure**: Countersunk or raised-head, cast-iron plug.
5. **Closure Plug Size**: Same as or not more than one size smaller than cleanout size.
6. **Wall Access**: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. **Wall Access**: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. **Plastic Floor Cleanouts**:

1. **Size**: Same as connected branch.
2. **Body**: PVC.
3. **Closure Plug**: PVC.
4. **Riser**: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

### 2.03 FLOOR DRAINS:

#### A. Cast-Iron Floor Drains:

1. **Standard**: ASME A112.6.3.
2. **Pattern**: Floor drain.
3. **Body Material**: Gray iron.
4. **Seepage Flange**: Where required.
5. **Anchor Flange**: Where required.
6. **Clamping Device**: Where required.
8. **Coating on Interior and Exposed Exterior Surfaces**: Acid-resistant enamel.
9. **Top or Strainer Material**: Nickel bronze or stainless steel.
10. **Top of Body and Strainer Finish**: Nickel bronze or stainless steel.
11. **Top Shape**: Round.
12. **Top Loading Classification**: Extra Heavy-Duty, Heavy Duty, Light Duty, Medium Duty, refer to plumbing fixture schedule.
13. **Funnel**: Where indicated.
15. **Trap Features**: Trap-seal primer valve drain connection.

### 2.04 TRENCH DRAINS:

#### A. Trench Drains:

1. **Standard**: ASME A112.6.3 for trench drains.
2. **Material**: Ductile or gray iron.
3. **Flange**: Anchor or Seepage as required.
4. **Clamping Device:** Where required.

5. **Grate Material:** Ductile iron or gray iron.

6. **Grate Finish:** Not required.

7. **Top Loading Classification:** Extra Heavy-Duty.

8. **Trap Pattern:** Standard P-trap.

### 2.05 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES:

#### A. Floor-Drain, Trap-Seal Primer Fittings:

1. **Description:** Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2. **Size:** Same as floor drain outlet with NPS 1/2 side inlet.

#### B. Air-Gap Fittings:

1. **Standard:** ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. **Body:** Bronze or cast iron.

3. **Inlet:** Opening in top of body.

4. **Outlet:** Larger than inlet.

5. **Size:** Same as connected waste piping and with inlet large enough for associated indirect waste piping.

#### C. Vent Caps:

1. **Description:** Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. **Size:** Same as connected stack vent or vent stack.

#### D. Expansion Joints:

1. **Standard:** ASME A112.21.2M.

2. **Body:** Cast iron with bronze sleeve, packing, and gland.

3. **End Connections:** Matching connected piping.

4. **Size:** Same as connected soil, waste, or vent piping.
PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. **Radius, 30 Inches or Less**: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. **Radius, 30 to 60 Inches**: Equivalent to 1 percent slope.
      c. **Radius, 60 Inches or Larger**: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. **Exception:** Fitting may be omitted if trap has trap-seal primer connection.
   2. **Size:** Same as floor drain inlet.

H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

I. Install vent caps on each vent pipe passing through roof.

J. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

K. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

L. Install wood-blocking reinforcement for wall-mounting-type specialties.

M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 **CONNECTIONS:**

A. Comply with requirements in SECTION 15150 - SANITARY WASTE AND VENT PIPING for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Ground equipment according to SECTION - 16060 GROUNDING AND BOUNDING.

D. Connect wiring according to SECTION 16120 – CONDUCTORS AND CABLES.

3.03 **FLASHING INSTALLATION:**

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

   1. **Lead Sheets:** Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

   2. **Copper Sheets:** Solder joints of copper sheets.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. **Pipe Flashing:** Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. **Sleeve Flashing:** Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. **Embedded Specialty Flashing:** Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 **LABELING AND IDENTIFYING:**

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in SECTION 15077 - IDENTIFICATION FOR HVAC, PLUMBING AND FIRE PROTECTION PIPING AND EQUIPMENT.

3.05 **PROTECTION:**

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 15181 - HYDRONIC PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Chilled-water piping.
   2. Condensate-drain piping.

1.03 DEFINITIONS:
A. PTFE: Polytetrafluoroethylene.

1.04 PERFORMANCE REQUIREMENTS:
A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Chilled-Water Piping: 150 psig at 200 deg F.
   2. Condensate-Drain Piping: 150 deg F.

1.05 ACTION SUBMITTALS:
A. Submit in accordance with Section 01300 - SUBMITTALS.
B. Product Data: For each type of the following:
   1. Plastic pipe and fittings with solvent cement.
   2. Pressure-seal fittings.
   3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   4. Air control devices.
   5. Hydronic specialties.
C. **Shop Drawings:** Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.06 **INFORMATIONAL SUBMITTALS:**
   
   A. Submit in accordance with Section 01300 - SUBMITTALS.
   
   B. Welding certificates.

1.07 **QUALITY ASSURANCE:**

   A. **Installer Qualifications:**
   
   1. **Installers of Pressure-Sealed Joints:** Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
   
   B. **Steel Support Welding:** Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   
   C. **Welding:** Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   
      1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
      
      2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

   D. **ASME Compliance:** Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

**PART 2 - PRODUCTS**

2.01 **COPPER TUBE AND FITTINGS:**

   A. **Drawn-Temper Copper Tubing:** ASTM B 88, Type L.
   
   B. **DWV Copper Tubing:** ASTM B 306, Type DWV.
   
   C. **Wrought-Copper Fittings:** ASME B16.22.
   
      1. **Grooved-End Copper Fittings:** ASTM B 75, copper tube or ASTM B 584, bronze casting.
2. **Grooved-End-Tube Couplings**: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

D. **Copper or Bronze Pressure-Seal Fittings**:

1. **Housing**: Copper.

2. **O-Rings and Pipe Stops**: EPDM.

3. **Tools**: Manufacturer's special tools.

4. Minimum 200-psig working-pressure rating at 250 deg F.

E. **Copper, Mechanically Formed Tee Option**: For forming T-branch on copper water tube.

1. **Basis-of-Design Product**: Subject to compliance with requirements, provide a comparable product by the following:
   
a. T-DRILL Industries Inc.

F. **Wrought-Copper Unions**: ASME B16.22.

### 2.02 STEEL PIPE AND FITTINGS:

A. **Steel Pipe**: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. **Cast-Iron Threaded Fittings**: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. **Malleable-Iron Threaded Fittings**: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. **Malleable-Iron Unions**: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. **Cast-Iron Pipe Flanges and Flanged Fittings**: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. **Wrought-Steel Fittings**: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. **Wrought Cast- and Forged-Steel Flanges and Flanged Fittings**: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. **Material Group**: 1.1.
2. **End Connections**: Butt welding.

3. **Facings**: Raised face.

H. **Grooved Mechanical-Joint Fittings and Couplings**:

1. **Basis-of-Design Product**: Subject to compliance with requirements, provide a comparable product by the following:
   
   a. Victaulic Company.

2. **Joint Fittings**: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. **Couplings**: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. **Steel Pipe Nipples**: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.03 **PLASTIC PIPE AND FITTINGS**:

A. **PVC Plastic Pipe**: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.


2.04 **JOINING MATERIALS**:

A. **Pipe-Flange Gasket Materials**: Suitable for chemical and thermal conditions of piping system contents.

   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

   a. **Narrow-Face Type**: For raised-face, Class 250, cast-iron and steel flanges.

B. **Flange Bolts and Nuts**: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. **Solder Filler Metals**: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Solvent Cements for Joining Plastic Piping:
   1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
      a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
   1. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.05 TRANSITION FITTINGS:

A. Plastic-to-Metal Transition Fittings:
   1. CPVC and PVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions:
1. MSS SP-107, CPVC and PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.06 DIELECTRIC FITTINGS:

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:
   b. Pressure Rating: 150 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 150 psig minimum at 180 deg F.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Nipples:

1. Description:
   a. Standard: IAPMO PS 66
   b. Electroplated steel nipple. complying with ASTM F 1545.
   c. Pressure Rating: 300 psig at 225 deg F.
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, propylene.

2.07 VALVES:

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "Valves."
B. **Bronze, Calibrated-Orifice, Balancing Valves:**

1. **Body:** Bronze, ball or plug type with calibrated orifice or venturi.
2. **Ball:** Brass or stainless steel.
3. **Plug:** Resin.
4. **Seat:** PTFE.
5. **End Connections:** Threaded or socket.
6. **Pressure Gage Connections:** Integral seals for portable differential pressure meter.
7. **Handle Style:** Lever, with memory stop to retain set position.
8. **CWP Rating:** Minimum 125 psig.
9. **Maximum Operating Temperature:** 250 deg F.

2.08 **AIR CONTROL DEVICES:**

A. **Manual Air Vents:**

1. **Body:** Bronze.
2. **Internal Parts:** Nonferrous.
3. **Operator:** Screwdriver or thumbscrew.
4. **Inlet Connection:** NPS 1/2.
5. **Discharge Connection:** NPS 1/8.
6. **CWP Rating:** 150 psig.
7. **Maximum Operating Temperature:** 225 deg F.

2.09 **HYDRONIC PIPING SPECIALTIES:**

A. **Y-Pattern Strainers:**

1. **Body:** ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. **End Connections:** Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. **Strainer Screen:** 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. **CWP Rating:** 125 psig.
B. **Stainless-Steel Bellow, Flexible Connectors:**

1. **Body:** Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. **End Connections:** Threaded or flanged to match equipment connected.
3. **Performance:** Capable of 3/4-inch misalignment.
4. **CWP Rating:** 150 psig.
5. **Maximum Operating Temperature:** 250 deg F.

**PART 3 - EXECUTION**

3.01 **PIPING APPLICATIONS:**

A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. **Condensate-Drain Piping:** Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.02 **VALVE APPLICATIONS:**

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.
3.03 PIPING INSTALLATIONS:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 15 Section "Valves."
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install sleeves for piping penetrations of walls, ceilings, and floors

U. Install sleeve seals for piping penetrations of concrete walls and slabs.

V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.04 HANGERS AND SUPPORTS:

A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.

2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.

4. Spring hangers to support vertical runs.

5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.

2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.

3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.

4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. **NPS 2-1/2**: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. **NPS 3**: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. **NPS 4**: Maximum span, 14 feet; minimum rod size, 1/2 inch.

**D.** Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. **NPS 3/4**: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. **NPS 1**: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. **NPS 1-1/2**: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. **NPS 2**: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. **NPS 2-1/2**: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. **NPS 3**: Maximum span, 10 feet; minimum rod size, 3/8 inch.

**E.** Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

**F.** Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

**3.05 PIPE JOINT CONSTRUCTION:**

**A.** Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

**B.** Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

**C.** Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

**D.** **Soldered Joints**: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

**E.** **Brazed Joints**: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.


H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.

4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

K. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

L. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

M. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
3.06 **HYDRONIC SPECIALTIES INSTALLATION:**
   
   A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.07 **TERMINAL EQUIPMENT CONNECTIONS:**
   
   A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
   
   B. Install control valves in accessible locations close to connected equipment.
   
   C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

END OF SECTION
SECTION 15195 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Service meters.
B. The tank, concrete base and regulator are provided by the gas company.

1.03 DEFINITIONS:
A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.04 PERFORMANCE REQUIREMENTS:
A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: 100 psig minimum unless otherwise indicated.
B. **Delegated Design:** Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by the University, using performance requirements and design criteria indicated.

1.05 **ACTION SUBMITTALS:**

A. Submit in accordance with SECTION 01300 – SUBMITTALS.

B. **Product Data:** For each type of the following:

1. Piping specialties.

2. **Valves:** Include pressure rating, capacity, settings, and electrical connection data of selected models.

3. **Service meters:** Indicate pressure ratings and capacities. Include bypass fittings and meter bars and supports.

4. Dielectric fittings.

C. **Shop Drawings:** For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

   1. **Shop Drawing Scale:** 1/4 inch per foot.

   2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

1.06 **CLOSEOUT SUBMITTALS:**

A. Submit in accordance with SECTION 01300 – SUBMITTALS.

B. **Operation and Maintenance Data:** For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.07 **QUALITY ASSURANCE:**

A. **Steel Support Welding Qualifications:** Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.08 **DELIVERY, STORAGE, AND HANDLING:**

A. **Handling Flammable Liquids:** Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
C. Store and handle pipes and tubes having factory-applied protective
coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.09 PROJECT CONDITIONS:

A. Perform site survey, research public utility records, and verify existing utility
locations. Contact utility-locating service for area where Project is located.

1.10 COORDINATION:

A. Coordinate sizes and locations of concrete bases with actual equipment
provided.

B. Coordinate requirements for access panels and doors for valves installed
concealed behind finished surfaces. Comply with requirements in
Division 8 Section - Access Doors and Frames.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS:

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S,
Grade B.

pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding
and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron
seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum
Class 150, including bolts, nuts, and gaskets of the following material
group, end connections, and facings:


   b. End Connections: Threaded or butt welding to match pipe.

   c. Lapped Face: Not permitted underground.

   d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free,
aluminum o-rings, and spiral-wound metal gaskets.

   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and
stainless steel underground.
5. **Mechanical Couplings:**
   
a. Steel flanges and tube with epoxy finish.

b. Buna-nitrile seals.

c. Steel bolts, washers, and nuts.

d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.02 **JOINING MATERIALS:**

A. **Joint Compound and Tape:** Suitable for natural gas.

2.03 **MANUAL GAS SHUTOFF VALVES:**

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. **General Requirements for Metallic Valves, NPS 2 and Smaller:** Comply with ASME B16.33.

   1. **CWP Rating:** 125 psig.

   2. **Threaded Ends:** Comply with ASME B1.20.1.

   3. **Dryseal Threads on Flare Ends:** Comply with ASME B1.20.3.


   5. **Listing:** Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

   6. **Service Mark:** Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. **One-Piece, Bronze Ball Valve with Bronze Trim:** MSS SP-110.

   1. **Body:** Bronze, complying with ASTM B 584.

   2. **Ball:** Chrome-plated brass.

   3. **Stem:** Bronze; blowout proof.

   4. **Seats:** Reinforced TFE; blowout proof.
5. **Packing:** Separate packnut with adjustable-stem packing threaded ends.


7. **CWP Rating:** 600 psig.

8. **Listing:** Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

9. **Service:** Suitable for natural-gas service with "WOG" indicated on valve body.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

   A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.02 **PREPARATION:**

   A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

   B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

   C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.03 **OUTDOOR PIPING INSTALLATION:**


   B. Install fittings for changes in direction and branch connections.

   C. Install pressure gage downstream from each service regulator.

3.04 **INDOOR PIPING INSTALLATION:**

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

M. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

N. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

O. Connect branch piping from top or side of horizontal piping.
P. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

Q. Do not use natural-gas piping as grounding electrode.

R. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.05 VALVE INSTALLATION:

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.06 PIPING JOINT CONSTRUCTION:

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

E. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
3.07 HANGER AND SUPPORT INSTALLATION:

A. Comply with requirements for pipe hangers and supports specified in SECTION 15062 - HANGERS AND SUPPORTS PIPING AND EQUIPMENT.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. **NPS 1 and Smaller**: Maximum span, 96 inches; minimum rod size, 3/8 inch.


3. **NPS 1-1/2 and NPS 2**: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3.08 CONNECTIONS:

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. **Sediment Traps**: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.09 LABELING AND IDENTIFYING:

A. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING:

A. Comply with requirements in Division 9 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. **Alkyd System**: MPI EXT 5.1D.
a. **Prime Coat**: Alkyd anticorrosive metal primer.

b. **Intermediate Coat**: Exterior alkyd enamel matching topcoat.

c. **Topcoat**: Exterior alkyd enamel semigloss.

d. **Color**: As selected by University.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. **Latex Over Alkyd Primer System**: MPI INT 5.1Q.
   a. **Prime Coat**: Alkyd anticorrosive metal primer.
   b. **Intermediate Coat**: Interior latex matching topcoat.
   c. **Topcoat**: Interior latex semigloss.
   d. **Color**: As selected by University.

D. **Damage and Touchup**: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 **DEMONSTRATION:**

A. Engage a factory-authorized service representative to train University's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 **OUTDOOR PIPING SCHEDULE:**

A. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 **INDOOR PIPING SCHEDULE:**

A. Aboveground, branch piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.14 **ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE:**

A. Valves for all pipe sizes shall be the following:

1. One-piece, bronze ball valve with bronze trim.

END OF SECTION
SECTION 15216 – GAS PIPING FOR LABORATORY AND HEALTHCARE
FACILITIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Waste Anesthesia Gas Disposal piping, designated "WAGD."
   2. Oxygen piping, designated "medical oxygen."

1.03 DEFINITIONS:
A. CR: Chlorosulfonated polyethylene synthetic rubber.

1.04 ACTION SUBMITTALS:
A. Submit in accordance with SECTION 01300 – SUBMITTALS.
B. Product Data: For each type of product.
C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS:
A. Submit in accordance with SECTION 01300 – SUBMITTALS.
B. Material Certificates: Signed by Installer certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.
C. Brazing certificates.
D. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS:
A. Submit in accordance with SECTION 01300 – SUBMITTALS.
B. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.
1.07 QUALITY ASSURANCE:

A. Installer Qualifications:
   3. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Medical oxygen operating at 50 to 55 psig.

2.02 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Medical gas manifolds shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the medical gas manifolds will remain in place without separation of any parts when subjected to the seismic forces specified."
   2. Component Importance Factor is 1.5.

2.03 PIPES, TUBES, AND FITTINGS:

A. Comply with NFPA 99 for medical gas piping materials.

B. Copper Medical Gas Tube: ASTM B 819, Type K, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service; or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY" in green for Type K tube and blue for Type L tube.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
E. **Cast-Copper-Alloy Flanges**: ASME B16.24, Class 150.
   1. **Pipe-Flange Gasket Materials**: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
   2. **Flange Bolts and Nuts**: ASME B18.2.1, carbon steel.
   3. **Description**: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

F. **PVC Pipe**: ASTM D 1785, Schedule 40.

G. **PVC Fittings**: ASTM D 2466, Schedule 40; socket type.

### 2.04 JOINING MATERIALS:

A. **Brazing Filler Metals**: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. **Threaded-Joint Tape**: PTFE.

C. **Solvent Cement for Joining PVC Piping**: ASTM D 2564. Include primer complying with ASTM F 656.

### 2.05 VALVES:

A. **General Requirements for Valves**: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. **Ball Valves**:
   1. **Standard**: MSS SP-110.
   2. **Description**: Three-piece body, brass or bronze.
   3. **Pressure Rating**: 300 psig minimum.
   4. **Ball**: Full-port, chrome-plated brass.
   5. **Seats**: PTFE or TFE.
   6. **Handle**: Lever.
   7. **Stem**: Blowout proof with PTFE or TFE seal.
   8. **Ends**: Manufacturer-installed ASTM B 819, copper-tube extensions and manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

C. **Pressure Regulators**:
   1. Bronze or Stainless-steel body and trim.
2. Spring-loaded, diaphragm-operated, relieving type.
4. Rated for 250-psig minimum inlet pressure.
5. Capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.06 GAS CYLINDER STORAGE RACKS:
A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

PART 3 - EXECUTION

3.01 PREPARATION:
A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
   1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.
   2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
      a. Scrub to ensure complete cleaning.
      b. Rinse with clean, hot water to remove cleaning solution.

3.02 PIPING INSTALLATION:
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Comply with NFPA 99 for installation of medical gas piping.
C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and for branch connections.

K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

L. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

M. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

N. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.

3.03 VALVE INSTALLATION:

A. Install shutoff valve at each connection to gas equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install pressure regulators on gas piping where reduced pressure is required.
3.04 JOINT CONSTRUCTION:

A. Ream ends of PVC pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

F. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. Apply primer and join according to ASME B31.9 and ASTM D 2672 for solvent-cemented joints.

3.05 GAS SERVICE COMPONENT INSTALLATION:

A. Install gas manifolds anchored to substrate.

B. Install gas cylinders and connect to manifold piping.

C. Install gas manifolds with seismic restraints.

3.06 HANGER AND SUPPORT INSTALLATION:

A. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or Type 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
E. **Base of Vertical Piping:** MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. **NPS 1/4:** 60 inches with 3/8-inch rod.
   2. **NPS 3/8 and NPS 1/2:** 72 inches with 3/8-inch rod.
   3. **NPS 3/4:** 84 inches with 3/8-inch rod.
   4. **NPS 1:** 96 inches with 3/8-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

### 3.07 IDENTIFICATION:

A. Install identifying labels and devices for specialty gas piping, valves, and specialties.

### 3.08 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS:

A. **Testing Agency:** Engage a qualified testing agency to perform tests and inspections.

B. **Tests and Inspections:**
   1. **Piping Leak Tests for Specialty Gas Piping:** Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

   2. Repair leaks and retest until no leaks exist.

   3. Inspect specialty gas regulators for proper operation.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

D. Prepare test and inspection reports.

### 3.09 PROTECTION:

A. Protect tubing from damage.
B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to “Preparation” Article.

3.10 DEMONSTRATION:
A. Engage factory-authorized service representative to train University’s maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.11 PIPING SCHEDULE:
A. Oxygen Piping: Type K, copper tube; wrought-copper fittings; and brazed joints.
B. WAGD Piping: PVC pipe, PVC fittings, and solvent-cemented joints.

3.12 VALVE SCHEDULE:
A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

END OF SECTION
SECTION 15732 - PACKAGED, CHILLED WATER AND DX OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units). One (AHU-1) has chilled water cooling coil and the other (RTU-1) has both a chilled water cooling coil and DX coil. They have the following components and accessories:
   B. Direct-expansion cooling.
   C. Chilled water cooling.
   D. Modulating Hot-gas reheat.
   E. Electric reheat.
   F. Roof curbs.

1.03 DEFINITIONS:
A. ECM: Electrically commutated motor.
B. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
C. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in units. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
D. RTU: Rooftop unit or PACU (Packaged Air Conditioning Unit). As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
E. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
F. **Supply-Air Refrigerant Coil:** Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. **VVT:** Variable-air volume and temperature.

### 1.04 PERFORMANCE REQUIREMENTS:

A. **Delegated Design:** Design unit supports to comply with seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. **Seismic Performance:** Units shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

C. 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."

### 1.05 ACTION SUBMITTALS:

A. Submit in accordance with Section 01300 - SUBMITTALS.

B. **Product Data:** Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, estimated sound power levels (dB), laminated color-coded wiring diagram affixed to interior of the control compartments' access door, furnished specialties, and accessories.

### 1.06 INFORMATIONAL SUBMITTALS:

A. Submit in accordance with Section 01300 - SUBMITTALS.

B. **Warranty:** Special warranty specified in this Section.

### 1.07 CLOSEOUT SUBMITTALS:

A. Submit in accordance with Section 01300 - SUBMITTALS.

B. **Operation and Maintenance Data:** For units to include emergency, operation, and maintenance manuals.

### 1.08 QUALITY ASSURANCE:

A. **ARI Compliance:**

1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. 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.

1.09 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

C. Warranty for Coils: One year from date of substantial completion.

D. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

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

B. AAON, Inc.

C. Carrier Corporation.
D. McQuay International.
E. Trane; American Standard Companies, Inc.

2.02 CASING:

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Unit shall be 2500 hr salt spray test in accordance with ASTM B 117-95 test, this would include interior and exterior casing, fans and dampers.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

C. Exterior Casing Thickness: G90 galvanized steel, 22 gauge.

D. Inner Casing Fabrication Requirements:
   Inside Casing: G90 galvanized steel, 22 gauge.

E. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   1. Materials: Foam insulation with minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F. Insulation with a minimum R-value of 13.

   2. Thickness: 2 inch.

F. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Drain Connections: Threaded nipple.
   3. Pan-Top Surface Coating: Corrosion-resistant compound.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.03 FANS:

A. Direct-Driven Supply-Air Fans: Unhoused, backward curved, plenum fan; with permanently lubricated, factory wired variable frequency drive. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Condenser-Coil Fan: Vertical discharge, axial flow, direct drive fans.
C. **Seismic Fabrication Requirements:** Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined when fan-mounted frame and unit-mounted frame are anchored to building structure.

D. **Fan Motor:** NEMA Premium Efficiency.

E. Variable frequency drive shall be provided with the unit but mounted within the building. Mechanical contractor shall provide power between the VFD and unit.

2.04 **COILS:**

A. **Supply-Air Refrigerant Coil:**
   1. Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing-type vertical distributor. Fin design shall be for R-410A refrigerant and sine wave rippled.
   2. **Coil Split:** Interlaced.
   3. Coil shall be furnished with a factory installed thermostatic expansion valve.

B. **Supply-Air Chilled Water Coil:**
   1. Coils shall be certified in accordance with AHRI Standard 410 and be leak tested.
   2. Coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.

C. **Cooling Coil general requirements:**
   1. Coils shall be helium leak tested.
   2. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied.
   3. **Condensate Drain Pan:** Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

D. **Outdoor-Air Refrigerant Coil:**
1. Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing-type vertical distributor.

2. **Coil Split**: Interlaced.

3. Coil shall be furnished with a factory installed thermostatic expansion valve.

4. Coils shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat.

5. **Condensate Drain Pan**: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

**E. Modulating Hot-Gas Reheat Coil:**

1. Requirements to match Supply-Air Refrigerant Coil.

**2.05 REFRIGERANT CIRCUIT COMPONENTS:**

**A. Number of Refrigerant Circuits**: Two.

**B. Compressor Characteristics:**

1. Compressor shall be a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.

2. Compressors shall be mounted in an isolated service compartment which can be accessed with lockable double hinged access doors and without affecting unit operation.

3. Compressor noise shall be isolated from the base pan with the compressor manufacturer’s recommended rubber vibration isolators.

**C. Refrigeration Specialties:**

1. **Refrigerant**: R-410A.

2. Expansion valve with replaceable thermostatic element.

3. Refrigerant filter/dryer.


5. Automatic-reset low-pressure safety switch.
8. Brass service valves installed in compressor suction and liquid lines.
9. Lead refrigeration circuit(s) shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

2.06 AIR FILTRATION:
   A. Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2. Refer to schedule for MERV rating.

2.07 DAMPERS:
   A. Outdoor-Air Damper: Motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge and end seals.

2.08 ELECTRICAL POWER CONNECTION:
   A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.09 CONTROLS:
   A. Basic Unit Controls:
      1. Control-voltage transformer.
      2. Unit shall be capable of standalone operation. Typically the unit will be controlled off of the BAS. However, when the unit is on stand-by power the unit shall be under standalone operation.
      3. Wall-mounted thermostat or sensor with the following features:
         b. Fan on-auto switch.
         c. Adjustable deadband.
         d. Concealed set point.
         e. Concealed indication.
f. Degree F indication.

g. Unoccupied-period-override push button.

4. **Wall-mounted humidistat or sensor with the following features:**
   a. Concealed set point.
   b. Concealed indication.

B. **Electronic Controller mounted remotely on wall:**

1. Controller shall have volatile-memory backup.

2. Digital display of outdoor-air temperature, supply-air temperature, space temperature, space humidity, fan running, filter dirty, unit alarm or failure and control parameters.

3. **Safety Control Operation:**
   a. **Smoke Detectors:** Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
   b. **Fire Alarm Control Panel Interface:** Provide control interface to coordinate with operating sequence described in Fire alarm specifications.

4. **Scheduled Operation:** Occupied and unoccupied periods on seven-day clock with a minimum of two programmable periods per day.

5. **Unoccupied Period:**
   a. **Cooling Setback:** System off and outside air damper closed.
   b. **Override Operation:** Two hours.

6. **Supply Fan Operation:**
   a. **Occupied Periods:** Variable speed fan system to modulate cooling and airflow as required in meeting the space temperature needs and to save unit operating energy. Unit fan speed shall modulate based on space temperature, not supply air pressure.
   b. **Unoccupied Periods:** Off.

7. **Refrigerant Circuit Operation:**
   a. **Occupied Periods:** Variable capacity compressor system to modulate cooling as required to maintain constant supply air temperature.
b. **Unoccupied Periods**: Compressors off.

8. **Hot-Gas Reheat-Coil Operation**:
   a. **Occupied Periods**: Modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity load, space temperatures and prevent supply air temperature swings and overcooling of the space.
   b. **Unoccupied Periods**: Reheat not required.

9. **Fixed Minimum Outdoor-Air Damper Operation**:
   a. **Occupied Periods**: Open since unit is 100% outside air.
   b. **Unoccupied Periods**: Close the outdoor-air damper.

2.10 **ACCESSORIES**:
   A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
   B. Coil guards of painted, galvanized-steel wire.

2.11 **ROOF CURBS**:
   A. **Materials**: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
      1. **Curb Insulation and Adhesive**: Comply with NFPA 90A or NFPA 90B.
         a. **Materials**: ASTM C 1071, Type I or II.
         b. **Thickness**: 2 inches.
      2. **Application**: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
         a. **Liner Adhesive**: Comply with ASTM C 916, Type I.
         b. **Mechanical Fasteners**: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
         c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
         d. **Liner Adhesive**: Comply with ASTM C 916, Type I.
e. Coordinate slope of roof curb with slope of roof.

B. **Curb Height**: 14 inches to match roof slope.

C. **Wind and Seismic Restraints**: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site.

**PART 3 - EXECUTION**

**3.01 EXAMINATION:**

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of units.

B. Examine roughing-in for units to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where units will be installed.

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

**3.02 INSTALLATION:**

A. **Roof Curb**: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." And ARI Guideline B. Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in architectural specifications. Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Section15074.

**3.03 CONNECTIONS:**

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to units to allow service and maintenance.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

   1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3. Connect supply ducts to units with flexible duct connectors.

4. Install return-air duct continuously through roof structure.

### 3.04 FIELD QUALITY CONTROL:

**A. Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

**B. Tests and Inspections:**

1. After installing units and after electrical circuitry has been energized, test units for compliance with requirements.

2. Inspect for and remove shipping bolts, blocks, and tie-down straps.

3. **Operational Test:** After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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

**C.** Remove and replace malfunctioning units and retest as specified above.

### 3.05 STARTUP SERVICE:

**A.** Engage a factory-authorized service representative to perform startup service.

**B.** Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.

2. Inspect for visible damage to compressor, coils, and fans.

3. Inspect internal insulation.

4. Verify that labels are clearly visible.

5. Verify that clearances have been provided for servicing.

6. Verify that controls are connected and operable.

7. Verify that filters are installed.

8. Clean condenser coil and inspect for construction debris.

9. Remove packing from vibration isolators.
10. Inspect operation of barometric relief dampers.

11. Verify lubrication on fan and motor bearings.

12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

13. Start unit according to manufacturer's written instructions.
   a. Start refrigeration system.
   b. Do not operate below recommended low-ambient temperature.
   c. Complete startup sheets and attach copy with Contractor's startup report.


15. Operate unit for an initial period as recommended or required by manufacturer.


17. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

18. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
   a. Coil leaving-air, dry- and wet-bulb temperatures.
   b. Coil entering-air, dry- and wet-bulb temperatures.
   c. Outdoor-air, dry-bulb temperature.
   d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

19. Inspect controls for correct sequencing of cooling mode and normal and emergency shutdown.

20. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air volume.
   c. Outdoor-air intake volume.

21. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

22. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.06 DEMONSTRATION:
A. Engage a factory-authorized service representative to train University's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION
SECTION 15815 - METAL DUCTS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Single-wall rectangular ducts and fittings.
      2. Single-wall round ducts and fittings.
      4. Sealants and gaskets.
      5. Hangers and supports.

1.03 PERFORMANCE REQUIREMENTS:
   A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
   B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 –SUBMITTALS.
   B. Product Data: For each type of the following products:
      1. Liners and adhesives.
      2. Sealants and gaskets.
   C. Shop Drawings:
      1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
      2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of top of ducts.

5. Dimensions of main duct runs from building grid lines.

6. Fittings.

7. Reinforcement and spacing.

8. Seam and joint construction.

9. Penetrations through fire-rated and other partitions.

10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.05 QUALITY ASSURANCE:

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS:

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. **Longitudinal Seams:** Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. **Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction:** Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Manufacturers of prefabricated systems must have duct construction and reinforcement guidelines along with supporting independent leakage and deflection performance testing. Manufacturer's prefabricated systems printed assembly and installation procedures must be adhered to during all phases.

F. All components of prefabricated system must be clearly embossed with manufacturer's markings and systems manufacturer clearly identified on all duct labels. No substitution of system components is permitted.

**2.02 SINGLE-WALL ROUND DUCTS AND FITTINGS:**

A. **General Fabrication Requirements:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. **Flat-Oval Ducts:** Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. **Transverse Joints:** Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. **Transverse Joints in Ducts Larger Than 60 Inches in Diameter:** Flanged.
D. **Longitudinal Seams:** Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. **Tees and Laterals:** Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. For duct construction pressure 2" w.g. or below:

1. **Round Ductwork:**
   a. Round low velocity ductwork shall be constructed from a minimum of 26 gauge, self-locking, pre-sealed snaplock pipe, which incorporates a factory applied gasket in the longitudinal seam and on the female end of the transverse joint.

2. **Fittings:**
   a. All High Efficiency Take-Offs, Conicals, and Collars must have a factory applied gasket along all rivets, co-latches, and flange. All fittings shall be constructed from a minimum of 26 gauge steel. All dampered fittings must have low-leakage hardware with closed-end bearings.

G. For duct construction pressure 3" w.g. or greater:

1. **Round Joints:**
   a. **Unexposed duct 3"-30" diameter:** Connect round duct with a one piece interior slip coupling, at least two gages heavier than duct wall, beaded at center and fastener to duct with screws. Seal joint with an approved sealant applied continuously around both end of coupler prior to assembling and after fastening

   b. **All exposed duct and unexposed duct 30"-72" diameter:** Install using a three piece, gasket flanged-joint consisting of two internal flanges, with integral mastic sealant, and one external closure band, which compress the gasket between the internal flanges

TECHNICAL SPECIFICATIONS
Metal Ducts
Project No. SW-12-6238
15815-4
c. **Above 72" diameter:** Install using companion angle flanged joints as defined in Figure 3-1 of the 2005 SMACNA Manual, “HVAC Duct Construction Standards, Metal & Flexible” Third Edition. Refer to manual for proper sizing and construction details.

d. Dust collection systems and exposed duct 3”-14” use a one piece, polyethylene lined gasket connector with integrated bolt for the closure system.

### 2.03 SHEET METAL MATERIALS:

A. **General Material Requirements:** Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. **Galvanized Sheet Steel:** Comply with ASTM A 653/A 653M.
   1. **Galvanized Coating Designation:** G90.
   2. **Finishes for Surfaces Exposed to View:** Mill phosphatized.

C. **Reinforcement Shapes and Plates:** ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. **Tie Rods:** Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.04 SEALANT AND GASKETS:

A. **General Sealant and Gasket Requirements:** Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. **Water-Based Joint and Seam Sealant:**
   1. **Application Method:** Brush on.
   2. **Solids Content:** Minimum 65 percent.
   3. **Shore A Hardness:** Minimum 20.
5. Mold and mildew resistant.
6. **VOC:** Maximum 75 g/L (less water).
7. **Maximum Static-Pressure Class:** 15-inch wg, positive and negative.
8. **Service:** Indoor or outdoor.
9. **Substrate:** Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. **Flanged Joint Sealant:** Comply with ASTM C 920.

1. **General:** Single-component, acid-curing, silicone, elastomeric.
2. **Type:** S.
3. **Grade:** NS.
4. **Class:** 25.
5. **Use:** O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. **Flange Gaskets:** Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer, which complies with UL 723 and meets Mil-C 18969B and TTS-S-001657. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth.

2.05 **HANGERS AND SUPPORTS:**

A. **Hanger Rods for Noncorrosive Environments:** Cadmium-plated steel rods and nuts.

B. **Hanger Rods for Corrosive Environments:** Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. **Strap and Rod Sizes:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
D. **Steel Cables for Galvanized-Steel Ducts**: Galvanized steel complying with ASTM A 603.

E. **Steel Cables for Stainless-Steel Ducts**: Stainless steel complying with ASTM A 492.

F. **Steel Cable End Connections**: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. **Duct Attachments**: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. **Trapeze and Riser Supports**:
   1. **Supports for Galvanized-Steel Ducts**: Galvanized-steel shapes and plates.
   2. **Supports for Stainless-Steel Ducts**: Stainless-steel shapes and plates.
   3. **Supports for Aluminum Ducts**: Aluminum or galvanized steel coated with zinc chromate.

### PART 3 - EXECUTION

#### 3.01 DUCT INSTALLATION:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.


3.02 INSTALLATION OF EXPOSED DUCTWORK:

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING:

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.04 HANGER AND SUPPORT INSTALLATION:

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. **Hanger Spacing:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. **Hangers Exposed to View:** Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 **CONNECTIONS:**

A. Make connections to equipment with flexible connectors complying with SECTION 15820 – DUCT ACCESSORIES.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 **PAINTING:**

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in SECTION 09900 – PAINTS & COATINGS.

3.07 **START UP**

A. **Air Balance:** Comply with requirements in SECTION 15950 – TESTING, ADJUSTING, AND BALANCING.
3.08 **DUCT SCHEDULE:**

A. Fabricate ducts with galvanized sheet steel.

B. **Supply Ducts:**

   1. **Ducts Connected to all Equipment:**
      a. **Pressure Class:** Positive 2-inch wg.
      b. **Minimum SMACNA Seal Class:** A.
      c. **SMACNA Leakage Class for Rectangular:** 6.
      d. **SMACNA Leakage Class for Round and Flat Oval:** 6.

C. **Exhaust Ducts:**

   1. **Ducts Connected to all Equipment:**
      a. **Pressure Class:** Positive or negative 3-inch wg.
      b. **Minimum SMACNA Seal Class:** A if negative pressure, and A if positive pressure.
      c. **SMACNA Leakage Class for Rectangular:** 6.
      d. **SMACNA Leakage Class for Round and Flat Oval:** 6.

D. **Intermediate Reinforcement:**

   1. **Galvanized-Steel Ducts:** Galvanized steel or carbon steel coated with zinc-chromate primer.

E. **Elbow Configuration:**

   1. **Rectangular Duct:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. **Velocity 1000 fpm or Lower:**
         1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         2) Mitered Type RE 4 without vanes.
      b. **Velocity 1000 to 1500 fpm:**
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. **Velocity 1500 fpm or Higher:**

   1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

   2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

   3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. **Rectangular Duct:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. **Round Duct:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

   a. **Minimum Radius-to-Diameter Ratio and Elbow Segments:**

      Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

      1) **Velocity 1000 fpm or Lower:** 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

      2) **Velocity 1000 to 1500 fpm:** 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

      3) **Velocity 1500 fpm or Higher:** 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) **Radius-to Diameter Ratio: 1.5.**

b. **Round Elbows, 12 Inches and Smaller in Diameter:** Stamped or pleated.

c. **Round Elbows, 14 Inches and Larger in Diameter:** Standing seam.

**F. Branch Configuration:**

1. **Rectangular Duct:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. **Rectangular Main to Rectangular Branch:** 45-degree entry.

   b. **Rectangular Main to Round Branch:** Spin in.

2. **Round and Flat Oval:** Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals,” and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. **Velocity 1000 fpm or Lower:** 90-degree tap.

   b. **Velocity 1000 to 1500 fpm:** Conical tap.

   c. **Velocity 1500 fpm or Higher:** 45-degree lateral.

**END OF SECTION**
SECTION 15820 - DUCT ACCESSORIES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Backdraft and pressure relief dampers.
   3. Remote damper operators.
   4. Duct-mounted access doors.
   5. Flexible connectors.
   6. Flexible ducts.
   7. Duct accessory hardware.

1.03 ACTION SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

1.04 INFORMATIONAL SUBMITTALS:
A. Submit in accordance with SECTION 01300 – SUBMITTALS.
B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS:
A. Submit in accordance with SECTION 01300 – SUBMITTALS.
B. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION:


B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS:

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS:

A. Description: Gravity balanced.

B. Maximum Air Velocity: 1000 fpm.

C. Maximum System Pressure: 2-inch wg.

D. Minimum System Pressure: 0.015-inch wg.

E. Frame: Hat-shaped, 0.063-inch- thick extruded aluminum, with welded corners or mechanically attached and mounting flange.
F. **Blades:** Multiple single-piece blades, off-center pivoted, maximum 6-inch width, 0.025-inch thick, roll-formed aluminum noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

G. **Blade Action:** Parallel.

H. **Blade Seals:** Neoprene, mechanically locked.

I. **Blade Axles:**
   1. **Material:** Stainless steel or Aluminum.
   2. **Diameter:** 0.20 inch.

J. **Tie Bars and Brackets:** Aluminum.

K. **Return Spring:** Adjustable tension.

L. **Bearings:** Steel ball or synthetic pivot bushings.

M. **Accessories:**
   1. Adjustment device to permit setting for varying differential static pressure.
   2. **Screen Material:** Aluminum.
   3. **Screen Type:** Bird.

2.04 **MANUAL VOLUME DAMPERS:**

A. **Low-Leakage, Aluminum, Manual Volume Dampers:**
   1. Comply with AMCA 500-D testing for damper rating.
   2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
   3. Suitable for horizontal or vertical applications.
   4. **Frames:** 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
   5. **Blades:**
      a. Multiple or single blade.
      b. Parallel or opposed-blade design.
      c. **Roll-Formed Aluminum Blades:** 0.10-inch thick aluminum sheet.
7. **Bearings:**
   
a. Oil-impregnated bronze, Molded synthetic, Oil-impregnated stainless-steel sleeve or Stainless-steel sleeve.

    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. **Blade Seals:** Neoprene.

9. **Accessories:**
   
a. Include locking device to hold single-blade dampers in a fixed position without vibration.

**B. Jackshaft:**

1. **Size:** 0.5-inch diameter.

2. **Material:** Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. **Length and Number of Mountings:** As required to connect linkage of each damper in multiple-damper assembly.

**C. Damper Hardware:**


2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

**2.05 REMOTE DAMPER OPERATORS:**

A. **Description:** Cable system designed for remote manual damper adjustment.

B. **Tubing:** Copper or Aluminum.

C. **Cable:** Steel.

D. **Wall-Box Mounting:** Recessed.
E. **Wall-Box Cover-Plate Material:** Steel.

2.06 **DUCT-MOUNTED ACCESS DOORS:**

A. **Duct-Mounted Access Doors:** Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. **Door:**
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. **Hinges and Latches:** 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. **Frame:** Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. **Number of Hinges and Locks:**
   a. **Access Doors Less Than 12 Inches Square:** No hinges and two sash locks.
   b. **Access Doors up to 18 Inches Square:** Two hinges and two sash locks.
   c. **Access Doors up to 24 by 48 Inches:** Three hinges and two compression latches with outside and inside handles.
   d. **Access Doors Larger Than 24 by 48 Inches:** Four hinges and two compression latches with outside and inside handles.

2.07 **DUCT ACCESS PANEL ASSEMBLIES:**

A. Labeled according to UL 1978 by an NRTL.

B. **Panel and Frame:** Minimum thickness 0.0528-inch carbon or 0.0428-inch stainless steel.

C. **Fasteners:** Stainless steel. Panel fasteners shall not penetrate duct wall.

D. **Gasket:** Comply with NFPA 96: grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
E. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.08 FLEXIBLE CONNECTORS:

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

   1. Minimum Weight: 14 oz./sq. yd.
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. **Overload Capacity:** Support 200 percent of rated load, fully compressed, without deformation or failure.

6. **Elastomeric Element:** Molded, oil-resistant rubber or neoprene.

7. **Coil Spring:** Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.09 **FLEXIBLE DUCTS:**

A. **Noninsulated, Flexible Duct:** UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.

1. **Pressure Rating:** 10-inch wg positive and 1.0-inch wg negative.

2. **Maximum Air Velocity:** 4000 fpm.

3. **Temperature Range:** Minus 20 to plus 210 deg F.

B. **Insulated, Flexible Duct:** UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. **Pressure Rating:** 10-inch wg positive and 1.0-inch wg negative.

2. **Maximum Air Velocity:** 4000 fpm.

3. **Temperature Range:** Minus 20 to plus 210 deg F.

4. **Insulation R-value:** Comply with ASHRAE/IESNA 90.1.

C. **Flexible Duct Connectors:**

1. **Clamps:** Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.10 **DUCT ACCESSORY HARDWARE:**

A. **Adhesives:** High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 **INSTALLATION:**

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Connect ducts to duct silencers rigidly.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot spacing.
   8. Upstream or downstream from duct silencers.
   9. Control devices requiring inspection.
   10. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.
I. **Access Door Sizes:**

1. **Two-Hand Access:** 12 by 6 inches.
2. **Head and Hand Access:** 18 by 10 inches.
3. **Head and Shoulders Access:** 21 by 14 inches.

J. Label access doors according to Division 15 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions. Terminal units in exposed areas will be connected directly.

N. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

END OF SECTION
SECTION 15840 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Shutoff, single-duct air terminal units.

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
      1. Air terminal units.
      2. Liners and adhesives.
      3. Sealants and gaskets.

1.04 CLOSEOUT SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals, include the following:
      1. Instructions for resetting minimum and maximum air volumes.
      2. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:
   A. Structural Performance: Hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
      1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

2.02 SYSTEM DESCRIPTION:

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.

2.03 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS:

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. METALAIRE, Inc.
2. Nailor Industries Inc.
3. Titus.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch steel, single wall.

1. Casing Lining: Adhesive attached, 1/2-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.

3. Air Outlet: S-slip and drive connections, size matching inlet size.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. **Electric-Resistance Heating Coils:** Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

1. Access door interlocked disconnect switch.
2. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
3. Nickel chrome 80/20 heating elements.
4. Airflow switch for proof of airflow.
5. Fan interlock contacts.
6. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
7. Mercury contactors.
8. Pneumatic-electric switches and relays.
9. Magnetic contactor for each step of control (for three-phase coils).

F. **Electronic Controls:** Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS and shall have the following features:

1. **Damper Actuator:** 24 V, powered closed, powered open.
2. **Velocity Controller:** Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
3. **Thermostat:** Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

G. **Control Sequence:**

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
2. System-powered, wall-mounted thermostat.
2.04 HANGERS AND SUPPORTS:
   A. **Hanger Rods for Noncorrosive Environments:** Cadmium-plated steel rods and nuts.
   B. **Hanger Rods for Corrosive Environments:** Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   C. **Steel Cables:** Galvanized steel complying with ASTM A 603.
   D. **Steel Cable End Connections:** Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
   E. **Air Terminal Unit Attachments:** Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
   F. **Trapeze and Riser Supports:** Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.05 SEISMIC-RESTRAINT DEVICES:
   A. **General Requirements for Restraint Components:** Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   B. **Channel Support System:** Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
   C. **Restraint Cables:** ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.
   D. **Hanger Rod Stiffener:** Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
   E. **Mechanical Anchor Bolts:** Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.01 INSTALLATION:
   A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.02 HANGER AND SUPPORT INSTALLATION:

A. Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.03 SEISMIC-RESTRAINT-DEVICE INSTALLATION:

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
F. **Attachment to Structure**: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. **Drilling for and Setting Anchors:**

   1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the University if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

   3. **Wedge Anchors**: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.

   4. Set anchors to manufacturer's recommended torque, using a torque wrench.

   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.04 CONNECTIONS:

   A. Make connections to air terminal units with flexible connectors complying with requirements in SECTION 15820 – DUCT ACCESSORIES.

3.05 IDENTIFICATION:

   A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in SECTION 15077 – IDENTIFICATION FOR HVAC, PLUMBING AND FIRE PROTECTION PIPING AND EQUIPMENT.

3.06 STARTUP SERVICE:

   A. Engage a factory-authorized service representative to perform startup service.

      1. Complete installation and startup checks according to manufacturer's written instructions.

      2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

      3. Verify that controls and control enclosure are accessible.

      4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.07 DEMONSTRATION:

A. Engage a factory-authorized service representative to train University's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION
SECTION 15855 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Square ceiling diffusers and registers.
      2. Grilles

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: For each type of product indicated, include the following:
      1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
      2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS
   B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
      1. Ceiling suspension assembly members.
      2. Method of attaching hangers to building structure.
      3. Size and location of initial access modules for acoustical tile.
      4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
      5. Duct access panels.
PART 2 - PRODUCTS

2.01 CEILING DIFFUSERS AND REGISTERS:

A. Square Ceiling Diffusers (Type 1):
   1. Material: Aluminum.
   2. Finish: Baked enamel, color selected by University.
   3. Face Size: 24 by 24 or 18 by 18 inches.
   5. Mounting: Lay-in.
   6. Accessories:
      a. Operating rod extension

2.02 GRILLES:

A. Supply, Return and Exhaust Grilles (Type 2 and 3):
   1. Material: Aluminum.
   2. Finish: Baked enamel, color selected by University.
   6. Frame: 1 inch wide.
   7. Mounting: Countersunk screw.
   8. Damper Type: Adjustable opposed blade.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING:

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:

A. General: As specified in Section 01001.

1.02 SUMMARY:

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls. Control system shall have a BACNET interface to integrate with the existing Johnson controls Metasys system. Contractor shall provide and coordinate the services of the Johnson Controls system’s servicing contractor to provide and install all interface connections, hardware, conduits, wiring and electrical power requirements for the integration of the new and existing control systems. Provide all necessary accessories as required for a complete operable system.

1.03 DEFINITIONS:

A. DDC: Direct digital control.
B. I/O: Input/output.
C. MS/TP: Master slave/token passing.
D. PC: Personal computer.
E. RTD: Resistance temperature detector.

1.04 SYSTEM PERFORMANCE:

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Any devices attached to ductwork shall have insulation between device and duct to avoid condensation.

4. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

5. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
6. **Alarm Response Time**: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

7. **Program Execution Frequency**: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

8. **Performance**: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

9. **Reporting Accuracy and Stability of Control**: Report values and maintain measured variables within tolerances as follows:
   a. **Water Temperature**: Plus or minus 1 deg F.
   b. **Space Temperature**: Plus or minus 1 deg F.
   c. **Ducted Air Temperature**: Plus or minus 1 deg F.
   d. **Outside Air Temperature**: Plus or minus 2 deg F.
   e. **Dew Point Temperature**: Plus or minus 3 deg F.
   f. **Temperature Differential**: Plus or minus 0.25 deg F.
   g. **Relative Humidity**: Plus or minus 5 percent.
   h. **Airflow (Pressurized Spaces)**: Plus or minus 3 percent of full scale.
   i. **Airflow (Measuring Stations)**: Plus or minus 5 percent of full scale.
   j. **Airflow (Terminal)**: Plus or minus 10 percent of full scale.
   k. **Air Pressure (Ducts)**: Plus or minus 0.1-inch wg.
   l. **Electrical**: Plus or minus 5 percent of reading.

1.05 **ACTION SUBMITTALS**:

A. Submit in accordance with Section 01300 - SUBMITTALS.

B. **Product Data**: Include manufacturer’s technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
1. **DDC System Hardware**: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. **Control System Software**: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. **Controlled Systems**: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

**C. Shop Drawings**: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

3. **Wiring Diagrams**: Power, signal, and control wiring.

4. Details of control panel faces, including controls, instruments, and labeling.

5. Written description of sequence of operation.

6. Schedule of dampers including size, leakage, and flow characteristics.

7. Schedule of valves including flow characteristics.

8. **DDC System Hardware**:

   a. Wiring diagrams for control units with termination numbers.

   b. Schematic diagrams and floor plans for field sensors and control hardware.

   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. **Control System Software**: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. **Controlled Systems:**
   
   a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
   
   b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
   
   c. Written description of sequence of operation including schematic diagram.
   
   d. Points list.

1.06 **CLOSEOUT SUBMITTALS:**

   A. Submit in accordance with Section 01300 - SUBMITTALS.

   B. **Operation and Maintenance Data:** For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals, include the following:

      1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.

      2. Interconnection wiring diagrams with identified and numbered system components and devices.


      4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

      5. Calibration records and list of set points.

1.07 **QUALITY ASSURANCE:**

   A. **Installer Qualifications:** Automatic control system manufacturer’s authorized representative who is trained and approved for installation of system components required for this Project.

   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 ASHRAE 135 for DDC system components.
1.08 DELIVERY, STORAGE, AND HANDLING:

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION:

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with SECTION 16442 - PANELBOARDS to achieve compatibility with starter coils and annunciation devices.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONTROL SYSTEM:

A. Manufacturers:

1. Johnson Controls, Inc.; Controls Group.

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 multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An 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.
2.03 **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 or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   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.

3. **Standard Application Programs:**
   a. **Electric Control Programs:** Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
   b. **HVAC Control Programs:** Optimal run time, supply-air reset, and enthalpy switchover.
   c. **Programming Application Features:** Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   d. Remote communications.
   e. Maintenance management.
   f. **Units of Measure:** Inch-pound.

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. **ASHRAE 135 Compliance:** Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

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.
   
   b. Discrete/digital, analog, and pulse I/O.
   
   c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

4. **ASHRAE 135 Compliance:** Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

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.

5. **Analog Outputs:** Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).

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; 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.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.04 **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 at calibration point.
2. **Wire:** Twisted, shielded-pair cable.
3. **Insertion Elements in Ducts:** Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.

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 long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. **Insertion Elements for Liquids:** Brass socket with minimum insertion length of 2-1/2 inches.
D. **Humidity Sensors:** Bulk polymer sensor element.
   1. **Accuracy:** 5 percent full range with linear output.
   2. **Room Sensor Range:** 20 to 80 percent relative humidity.

E. **Pressure Transmitters/Transducers:**
   1. **Static-Pressure Transmitter:** Nondirectional sensor with suitable range for expected input, and temperature compensated.
      a. **Accuracy:** 2 percent of full scale with repeatability of 0.5 percent.
      b. **Output:** 4 to 20 mA.
      c. **Building Static-Pressure Range:** 0- to 0.25-inch wg.
      d. **Duct Static-Pressure Range:** 0- to 5-inch wg.

2.05 **STATUS SENSORS:**

A. **Status Inputs for Fans:** Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. **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.

C. **Electronic Valve/Damper Position Indicator:** Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.06 **THERMOSTATS:**

A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
   1. Automatic switching from heating to cooling.
   2. Preferential rate control to minimize overshoot and deviation from set point.
   3. Set up for four separate temperatures per day.
   4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
   5. Short-cycle protection.
   6. Programming based on every day of week.
7. Selection features include degree F, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.

8. Battery replacement without program loss.

9. Thermostat display features include the following:
   a. Time of day.
   b. Actual room temperature.
   c. Programmed temperature.
   d. Programmed time.

2.07 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. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
   a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
   a. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

C. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.

2. Thermostatic Operator: Wax-filled remote sensor with remote adjustable dial.

2.08 CONTROL CABLE:

A. Electronic and fiber-optic cables for control wiring are specified in electrical specifications.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that power supply is available to control units and operator workstation.

3.02 INSTALLATION:

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

D. Install automatic dampers according to SECTION 15820 - DUCT ACCESSORIES.

E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install labels and nameplates to identify control components according per specs.

G. Install electronic and fiber-optic cables according to electrical specifications.
3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION:

A. Install raceways, boxes, and cabinets according to SECTION 16130 - RACEWAYS AND BOXES.

B. Install building wire and cable according to SECTION 16120 - CONDUCTORS AND CABLES.

C. Install signal and communication cable per electrical specifications.
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install concealed cable in raceway.
   4. Bundle and harness multi conductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.04 ADJUSTING:

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer’s written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.

c. Check digital inputs using jumper wire.

d. Check digital outputs using ohmmeter to test for contact making or breaking.

e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. **Flow**:

   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.

   b. Manually operate flow switches to verify that they make or break contact.

6. **Pressure**:

   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.

   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. **Temperature**:

   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistant source.

   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

   **B. Adjust initial temperature and humidity set points.**
3.05 DEMONSTRATION:

A. Engage a factory-authorized service representative to train University's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION
SECTION 15950 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Balancing Air Systems:
         a. Constant-volume air systems.
         b. Variable-air-volume systems.
      2. Balancing Hydronic Piping Systems:
         a. Variable-flow hydronic systems.

1.03 DEFINITIONS:
   C. TAB: Testing, adjusting, and balancing.
   D. TABB: Testing, Adjusting, and Balancing Bureau.
   E. TAB Specialist: An entity engaged to perform TAB Work.

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
   C. Certified TAB reports.
   D. Sample report forms.

1.05 QUALITY ASSURANCE:
   A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC NEBB or TABB.
1. **TAB Field Supervisor**: Employee of the TAB contractor and certified by AABC NEBB or TABB.

2. **TAB Technician**: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.

B. **TAB Conference**: Meet with University on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. **Agenda Items**:
   b. The TAB plan.
   c. Coordination and cooperation of trades and subcontractors.
   d. Coordination of documentation and communication flow.

C. **Certify TAB field data reports and perform the following**:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. **TAB Report Forms**: Use standard TAB contractor's forms approved by University.

E. **Instrumentation Type, Quantity, Accuracy, and Calibration**: As described in ASHRAE 111, Section 5, "Instrumentation."

F. **ASHRAE Compliance**: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

1.06 **PROJECT CONDITIONS**:

A. **Full University Occupancy**: University will occupy the site and existing building during entire TAB period. Cooperate with University during TAB operations to minimize conflicts with University's operations.

B. **Partial University Occupancy**: University may occupy completed areas of building before Substantial Completion. Cooperate with University during TAB operations to minimize conflicts with University's operations.
1.07 **COORDINATION:**

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

**PART 2 - PRODUCTS (Not Applicable)**

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

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

E. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.
H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Examine operating safety interlocks and controls on HVAC equipment.

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

3.02 PREPARATION:

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

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

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in SECTION 15820 - DUCT ACCESSORIES.

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to SECTION 15086 - DUCT INSULATION and SECTION 15088 - HVAC PIPING INSULATION.

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

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS:

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

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
G. Verify that motor starters are equipped with properly sized thermal protection.

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

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

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

L. Verify that air duct system is sealed as specified in SECTION 15815 - METAL DUCTS.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS:

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:
   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from University for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.
3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS:

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.
3.07 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS:

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.08 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS:

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.09 PROCEDURES FOR MOTORS:

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. **Motors Driven by Variable-Frequency Controllers**: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 **PROCEDURES FOR HEAT-TRANSFER COILS**:

A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.11 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS:

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   1. Measure and record the operating speed, airflow, and static pressure of each fan.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the refrigerant charge.
   4. Check the condition of filters.
   5. Check the condition of coils.
   6. Check the operation of the drain pan and condensate-drain trap.
   7. Check bearings and other lubricated parts for proper lubrication.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.12 TOLERANCES:

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.13 REPORTING:

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

3.14 FINAL REPORT:

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. **Final Report Contents**: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers’ test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. **General Report Data**: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. University’s name and address.
7. Signature of TAB supervisor who certifies the report.
8. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
9. **Summary of contents including the following**:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
10. Nomenclature sheets for each item of equipment.
11. Data for terminal units, including manufacturer’s name, type, size, and fittings.
12. Notes to explain why certain final data in the body of reports vary from indicated values.
13. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. Return-air damper position.
m. Vortex damper position.

F. **Apparatus-Coil Test Reports:**

1. **Coil Data:**
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. **Test Data (Indicated and Actual Values):**
   a. Air flow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. **Electric-Coil Test Reports:** For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. **Unit Data:**
   a. System identification.
   b. Location.
   c. Coil identification.
   d. Capacity in Btu/h.
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Air flow rate in cfm.
   i. Face area in sq. ft.
   j. Minimum face velocity in fpm.

2. **Test Data (Indicated and Actual Values):**
   a. Heat output in Btu/h.
   b. Air flow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in deg F.
   e. Leaving-air temperature in deg F.
   f. Voltage at each connection.
   g. Amperage for each phase.

H. **Fan Test Reports:** For supply, return, and exhaust fans, include the following:

1. **Fan Data:**
   a. System identification.
   b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

   1. Report Data:
      a. System and air-handling-unit number.
      b. Location and zone.
      c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.

e. Duct size in inches.

f. Duct area in sq. ft.

g. Indicated air flow rate in cfm.

h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Apparatus used for test.
   d. Area served.
   e. Make.
   f. Number from system diagram.
   g. Type and model number.
   h. Size.
   i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary air flow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final air flow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in deg F.
K. **System-Coil Reports:** For reheat coils and water coils of terminal units, include the following:

1. **Unit Data:**
   a. System and air-handling-unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. **Test Data (Indicated and Actual Values):**
   a. Air flow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

L. **Instrument Calibration Reports:**

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

3.15 **INSPECTIONS:**

A. **Initial Inspection:**

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. **Check the following for each system:**
   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure water flow of at least 5 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

B. **Final Inspection:**

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by University.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of University.

3. University shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. **TAB Work will be considered defective if it does not pass final inspections.** If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, University may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. **Prepare test and inspection reports.**
3.16 **ADDITIONAL TESTS:**

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. **Seasonal Periods:** If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION
DIVISION 16 - ELECTRICAL

SECTION 16050 – REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL:

1.01 GENERAL REQUIREMENTS:

A. General: As specified in Section 01001.

1.02 SUMMARY:

A. The section applies to applicable Division 13 and 16 sections.

B. Furnish and install electrical wiring, systems, equipment, accessories, tests, adjustments, instructions and documentation in accordance with the specifications and drawings for a proper, complete, satisfactory and operable system.

C. Capacities and ratings of motors, transformers, cables, switchboards, switchgear, panelboards, motor control centers, and other electrical items and arrangements shall be of sufficient capacity as shown on drawings, specifications and as required by the applicable National Electrical Code, codes and standards.

1.03 RELATED WORK:

A. Telecommunication equipment and wiring.

B. Fire Alarm System equipment and wiring.

C. Security System equipment and wiring.

D. Audio Visual System equipment and wiring.

1.04 RULES, REGULATIONS AND STANDARDS:

A. Comply with local ordinances and building department directives including the International Building Code, National Electrical Code, Uniform Fire Code, statutes and official requirements of the State of Hawaii.

B. Apply and pay for electrical permit.

C. Comply with serving utility agency rules and requirements, and pay for service charges levied by such agencies for work performed during the agencies’ non-working hours and days.

D. Applicable Documents: Relevant definitions and requirements to current versions of applicable ANSI, UL, NEMA, EEI, IEEE, NFPA, TIA/EIA, ADAAGS references.
1.05 DRAWINGS AND SPECIFICATIONS:

A. Electrical drawings are illustrative and representational. Locations of outlets, devices, raceways, apparatus and other electrical items shown are approximate and shall be installed with the required maintenance and code clearances and to correct inconsistencies with existing conditions, other building systems and trades. Survey site and building conditions to verify lineal footages required and check scales and dimensions shown on construction drawings, verify locations, routing and lineal footages of electrical work required. Study existing civil, architectural, structural and mechanical conditions and install electrical system orderly and coordinated with existing site and building appurtenances.

B. Provide additional components and wiring not shown or specified herein but are required for proper control and operation to provide for a complete and operable system within intent indicated on the drawings and specifications.

C. Conduct site survey and thoroughly review drawings and specifications prior to bidding to provide necessary wiring, apparatus, devices and other equipment for a complete installation included in the bid.

D. Relocate devices, apparatus and associated wiring including raceways, from locations shown, included in the bid, for code compliance and to correct inconsistencies with existing conditions, structures, utilities and when directed before installation.

E. Equipment ratings and wire sizes shall have adequate capacity to serve the required load and be in compliance with the NEC.

F. Verify voltages and other ratings of electrical utilization equipment prior to placing order with factory. Input voltages of equipment shall match serving utility or system voltage available.

G. Where inconsistencies between the drawings, specifications, referenced codes, standards and requirements exist, the more rigorous requirement shall govern.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Equipment and material shall be listed, labeled or certified for the intended application by a recognized testing organization to meet Underwriters Laboratories, Inc., standards where test standards have been established and in accordance with the National Electrical code.

B. Where equipment and material are specified by catalog numbers and names that are of obsolescence, supersedure, or error in identification, the intent implied by the description, application, required performance and features noted shall govern.
C. Equipment and materials shall be suitable for intended location and use and include all accessories for proper installation and operation.

PART 3 - EXECUTION

3.01 INSTALLATION:


1. Installation shall be appropriate for intended location and use and be complete and operable within intent indicated on the plans and specifications. Provide all accessories as required for proper installation and operation.

2. For actual fabrication, installation and testing of the work use only certified, trained and experienced workmen familiar with items required and with manufacturers’ recommended methods of installation. Rejection of installed work made due to the lack of skill shall be corrected included in the bid.

3. Factory trained technician shall perform work for electrical items where specifically recommended by the manufacturer.

B. Cut and Patch: Trench, excavate, cut and core as required to install electrical systems.

1. Backfill, repair and patch walls, floors, ceilings and structure and pavement and replant/regrass as required to restore finished surfaces, grade and landscape to original condition. Paint exposed raceways and boxes to match surrounding finish.

2. Seal all excess openings.

3. Carefully chip concrete to avoid cutting structural steel. Repair any damage to rebars by welding.

C. Equipment Connections: Unless indicated otherwise, provide wiring for all equipment furnished by other trades. Provide disconnect switches for all motorized equipment and water heaters. Install starters and controllers furnished by other trades. Wiring shown on any drawing is based on equipment rating with the University or trade furnishing equipment and adjust wiring and associated protective device as required to accommodate actual size of equipment to be furnished. Trench, excavate, cut and core as required to install electrical systems.
1. Check and insure that proper polarity and phase rotation is provided for all outlets and equipment connections.

D. **Existing Conditions:** Verify existing field conditions prior to bidding. Reroute existing electrical and signal/communication lines and relocate equipment as necessary to avoid conflict with new construction.

1. Verify and check traverse of new electrical, signal and telecommunication lines for possible conflicts with existing utilities and obstructions and new construction prior to installation of new lines.

2. Repair any existing utility lines damaged during construction included in the bid.

3. Remove existing wiring and equipment no longer in use. Phase removal and new work as required to allow existing facilities to remain operational.

E. **Restrictions:**

1. Noisy construction operations which interfere with the usual existing procedures in adjacent areas shall be scheduled with University.

F. **Adjustment and Settings:**

1. Adjust breaker trips and other equipment settings and controls per manufacturer's recommendations and as required unless otherwise directed.

2. Balance feeder loading equally on each phase as closely as practicable. Rearrange feeder and branch circuit connections as necessary to balance loads.

3.02 **OUTAGES:**

A. Schedule all work to minimize power outages. Outages will be permitted only after normal operating hours unless approved by the University. Contractor shall request for outages in writing at least two weeks in advance. Contractor shall pay for charges for work required after normal operating hours and provide temporary power and wiring as necessary included in the bid.
SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes: Grounding systems and equipment

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each type of product indicated.

1.04 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Informational Submittals: Plans showing dimensioned grounding features including the following:
      1. Ground rods.
      2. Grounding arrangements and connections for separately derived systems.
   C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals, include the following:
      1. Instructions for periodic testing and inspection of grounding features based on NFPA 70B.
         a. Tests shall determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
         b. Include recommended testing intervals.
PART 2 - PRODUCTS

2.01 CONDUCTORS:

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.02 CONNECTORS:

A. Listed and labeled by an NRTL 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, 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.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.03 GROUNDING ELECTRODES:

A. Ground Rods: Copper-clad steel, sectional type; 96 by 5/8 inches in diameter.
PART 3 - EXECUTION

3.01 APPLICATIONS:

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 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 below grade.

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 telecommunication equipment rooms, in rooms housing equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches 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, and down to specified height above floor; 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 Structural Steel: Welded connectors.

3.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS:

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
C. **Grounding Connections to Manhole Components:** Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. **Pad-Mounted Transformers and Switches:** Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.03 **EQUIPMENT GROUNDING:**

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. **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.

C. **Water Heater:** Install a separate insulated equipment grounding conductor to each electric water heater.

D. **Isolated Equipment Enclosure Circuits:** For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. **Signal and Communication Equipment:** In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. 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.
2. **Service and Central Equipment Locations and Wiring Closets:** Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

3. **Terminal Cabinets:** Terminate grounding conductor on cabinet grounding terminal.

F. **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.

### 3.04 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. **Ground Rods:** Drive rods until tops are 2 inches 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 two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. **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 bonding so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. **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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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.

E. **Bonding Interior Metal Ducts:** Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

F. **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 60 feet (18 m) apart.

G. **Ufer Ground (Concrete-Encased Grounding Electrode):** Fabricate according to NFPA 70; use 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's grounding grid or to grounding electrode external to concrete.

3.05 **LABELING:**

A. Comply with requirements in SECTION 16075 - ELECTRICAL IDENTIFICATION for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

   1. **Label Text:** "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.06 **FIELD QUALITY CONTROL:**

A. **Tests and Inspections:**
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance no fewer 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 81.

4. 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.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values: 5 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify University promptly and include recommendations to reduce ground resistance.

END OF SECTION
SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 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: SECTION 16074 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS for products and installation requirements necessary for compliance with seismic criteria.

1.03 DEFINITIONS:
   A. EMT: Electrical metallic tubing.
   B. RMC: Rigid metal conduit.

1.04 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.

1.05 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For the following:
      1. Steel slotted support systems.
      2. Nonmetallic slotted support systems.
C. **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.

1.06 **INFORMATIONAL SUBMITTALS:**
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Welding certificates.

1.07 **QUALITY ASSURANCE:**
A. **Welding:** Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

1.08 **COORDINATION:**
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

PART 2 - PRODUCTS

2.01 **SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS:**
A. **Steel Slotted Support Systems:** Comply with MFMA-4, factory-fabricated components for field assembly.

1. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Tube & Conduit or pre-approved equal.

b. Cooper B-Line, Inc.; a division of Cooper Industries or pre-approved equal.

c. ERICO International Corporation or pre-approved equal.

d. GS Metals Corp. or pre-approved equal.

e. Thomas & Betts Corporation or pre-approved equal.
f. Unistrut; Tyco International, Ltd. or pre-approved equal.

g. Wesanco, Inc. or pre-approved equal.

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.

5. **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 8 inches (200 mm) o.c., in at least 1 surface.

1. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Allied Tube & Conduit or pre-approved equal.

   b. Cooper B-Line, Inc.; a division of Cooper Industries or pre-approved equal.

   c. Fabco Plastics Wholesale Limited or pre-approved equal.

   d. Seasafe, Inc. or pre-approved equal.

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. **Structural Steel for Fabricated Supports and Restraints:** ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. **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. **Available Manufacturers**: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) Hilti Inc. or pre-approved equal.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc. or pre-approved equal.
      3) MKT Fastening, LLC or pre-approved equal.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit or pre-approved equal.

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. **Available Manufacturers**: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) Cooper B-Line, Inc.; a division of Cooper Industries or pre-approved equal.
      2) Empire Tool and Manufacturing Co., Inc. or pre-approved equal.
      3) Hilti Inc. or pre-approved equal.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc. or pre-approved equal.
      5) MKT Fastening, LLC or pre-approved equal.

3. **Concrete Inserts**: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. **Clamps for Attachment to Steel Structural Elements**: MSS SP-58, type suitable for attached structural element.

5. **Through Bolts**: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. **Toggle Bolts**: All-steel springhead type.

7. **Hanger Rods**: Threaded steel.

### 2.02 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 SECTION 05500 - METAL FABRICATIONS – COMMON WORK RESULTS for steel shapes and plates.

### PART 3 - EXECUTION

#### 3.01 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 70. Minimum rod size shall be 1/4 inch (6 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 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

#### 3.02 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 70.
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.
5. 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. **To Steel:** Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. **To Light Steel:** Sheet metal screws.
8. **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.

3.03 **INSTALLATION OF FABRICATED METAL SUPPORTS:**

A. Comply with installation requirements in SECTION 05500 - METAL FABRICATIONS – COMMON WORK RESULTS 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.
3.04 **CONCRETE BASES:**

A. Construct concrete bases of dimensions indicated but not less than 4 inches 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 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in SECTION 03300 - 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.

3.05 **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.

B. **Touchup:** Comply with requirements in SECTION 09900 – PAINTS & COATINGS 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 780.

END OF SECTION
SECTION 16074 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. This Section includes the following:
      1. Isolation pads.
      2. Spring isolators.
      3. Restrained spring isolators.
      4. Channel support systems.
      5. Restraint cables.
      6. Hanger rod stiffeners.
      7. Anchorage bushings and washers.
   B. Related Section: SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for commonly used electrical supports and installation requirements.

1.03 DEFINITIONS:
   C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.04 PERFORMANCE REQUIREMENTS:
   A. Seismic-Restraint Loading:
      1. Site Class as Defined in the IBC: As indicated by Architectural and Structural documents.
      2. Assigned Seismic Use Group or Building Category as Defined in the IBC: As indicated by Architectural and Structural documents.
         a. Component Importance Factor: As indicated by Architectural and Structural documents.
b. **Component Response Modification Factor:** As indicated by Architectural and Structural documents.

c. **Component Amplification Factor:** As indicated by Architectural and Structural documents.

1.05 QUALITY ASSURANCE:

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. **Welding:** Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by University.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS:

A. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ace Mountings Co., Inc. or pre-approved equal.
2. Amber/Booth Company, Inc. or pre-approved equal.
3. California Dynamics Corporation or pre-approved equal.
4. Isolation Technology, Inc. or pre-approved equal.
5. Kinetics Noise Control or pre-approved equal.
6. Mason Industries or pre-approved equal.
7. Vibration Eliminator Co., Inc. or pre-approved equal.
8. Vibration Isolation or pre-approved equal.
9. Vibration Mountings & Controls, Inc. or pre-approved equal.
B. **Pads:** Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. **Resilient Material:** Oil- and water-resistant, neoprene or rubber or hermetically sealed compressed fiberglass.

C. **Spring Isolators:** Freestanding, laterally stable, open-spring isolators.

1. **Outside Spring Diameter:** Not less than 80 percent of the compressed height of the spring at rated load.

2. **Minimum Additional Travel:** 50 percent of the required deflection at rated load.

3. **Lateral Stiffness:** More than 80 percent of rated vertical stiffness.

4. **Overload Capacity:** Support 200 percent of rated load, fully compressed, without deformation or failure.

5. **Baseplates:** Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.

6. **Top Plate and Adjustment Bolt:** Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. **Restrained Spring Isolators:** Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. **Housing:** Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. **Restraint:** Seismic or limit-stop as required for equipment and authorities having jurisdiction.

3. **Outside Spring Diameter:** Not less than 80 percent of the compressed height of the spring at rated load.

4. **Minimum Additional Travel:** 50 percent of the required deflection at rated load.

5. **Lateral Stiffness:** More than 80 percent of rated vertical stiffness.

6. **Overload Capacity:** Support 200 percent of rated load, fully compressed, without deformation or failure.
2.02 SEISMIC-RESTRAINT DEVICES:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc. or pre-approved equal.
2. California Dynamics Corporation or pre-approved equal.
3. Cooper B-Line, Inc.; a division of Cooper Industries or pre-approved equal.
4. Hilti Inc. or pre-approved equal.
5. Loos & Co.; Seismic Earthquake Division or pre-approved equal.
6. Mason Industries or pre-approved equal.
7. TOLCO Incorporated; a brand of NIBCO INC. or pre-approved equal.
8. Unistrut; Tyco International, Ltd. or pre-approved equal.

B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

C. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.

E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
H. **Mechanical Anchor:** Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

I. **Adhesive Anchor:** Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

### 2.03 FACTORY FINISHES:

A. **Finish:** Manufacturer's standard prime-coat finish ready for field painting.

B. **Finish:** Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

**PART 3 - EXECUTION**

### 3.01 EXAMINATION:

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

### 3.02 APPLICATIONS:

A. **Multiple Raceways or Cables:** Secure raceways and cables to trapeze member with approved clamps.
B. **Hanger Rod Stiffeners:** Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. **Strength of Support and Seismic-Restraint Assemblies:** Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 **SEISMIC-RESTRAINT DEVICE INSTALLATION:**

A. **Equipment and Hanger Restraints:**

1. Install restrained isolators on electrical equipment.

2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install seismic-restraint devices using approved methods.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. **Attachment to Structure:** If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. **Drilled-in Anchors:**

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the University if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. **Wedge Anchors:** Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. **Adhesive Anchors:** Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.05 FIELD QUALITY CONTROL:

A. Perform tests and inspections.

B. Tests and Inspections.

1. Schedule test with University, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.

2. Obtain University's approval before transmitting test loads to structure. Provide temporary load-spreading members.

3. Test at least four of each type and size of installed anchors and fasteners selected by University.

4. Test to 90 percent of rated proof load of device.

5. Measure isolator restraint clearance.

6. Measure isolator deflection.

7. Verify snubber minimum clearances.

8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.06 ADJUSTING:

A. Adjust isolators after isolated equipment is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION
SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Identification for raceways.
      2. Identification of power and control cables.
      3. Identification for conductors.
      5. Warning labels and signs.
      6. Instruction signs.
      7. Equipment identification labels.
      8. Miscellaneous identification products.

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each electrical identification product indicated.
   C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
   D. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.04 QUALITY ASSURANCE:
   B. Comply with NFPA 70.
   D. Comply with ANSI Z535.4 for safety signs and labels.
   E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
1.05 **COORDINATION:**

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer’s wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. 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**

2.01 **POWER RACEWAY 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 size.

B. **Colors for Raceways Carrying Circuits at 600 V or Less:**
   1. Black letters on an orange field
   2. **Legend:** Indicate voltage and system or service type.

2.02 **POWER AND CONTROL 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.

2.03 **CONDUCTOR IDENTIFICATION MATERIALS:**

A. **Color-Coding Conductor Tape:** Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

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.
2.04 UNDERGROUND-LINE WARNING TAPE:

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE

C. Tag:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.

2. Overall Thickness: 5 mils.

3. Foil Core Thickness: 0.35 mil.


5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf and 4600 psi.

2.05 WARNING LABELS AND SIGNS:


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:**

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. 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 36 INCHES."

2.06 **INSTRUCTION SIGNS:**

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch 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.

2.07 **EQUIPMENT IDENTIFICATION LABELS:**

A. **Engraved, Laminated Acrylic or Melamine Label:** Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.08 **CABLE TIES:**

A. **General-Purpose Cable Ties:** Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. **Minimum Width:** 3/16 inch.
2. **Tensile Strength at 73 deg F, According to ASTM D 638:** 12,000 psi.
3. **Temperature Range:** Minus 40 to plus 185 deg F.
4. **Color:** Black except where used for color-coding.
B. **UV-Stabilized Cable Ties**: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. **Minimum Width**: 3/16 inch.
   2. **Tensile Strength at 73 deg F, According to ASTM D 638**: 12,000 psi.
   3. **Temperature Range**: Minus 40 to plus 185 deg F.
   4. **Color**: Black.

C. **Plenum-Rated Cable Ties**: Self extinguishing, UV stabilized, one piece, self locking.
   1. **Minimum Width**: 3/16 inch.
   2. **Tensile Strength at 73 deg F, According to ASTM D 638**: 7000 psi.
   3. **UL 94 Flame Rating**: 94V-0.
   4. **Temperature Range**: Minus 50 to plus 284 deg F.
   5. **Color**: Black.

2.09 **MISCELLANEOUS IDENTIFICATION PRODUCTS**:

A. **Paint**: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. **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**

3.01 **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 signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. **System Identification Color-Coding Bands for Raceways and Cables:** Each color-coding 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 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. **Aluminum Wraparound Marker Labels and Metal Tags:** Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. **Cable Ties:** For attaching tags. Use general-purpose type, except as listed below:
   1. **Outdoors:** UV-stabilized nylon.
   2. **In Spaces Handling Environmental Air:** Plenum rated.

I. **Underground-Line Warning Tape:** During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

J. **Painted Identification:** Comply with requirements in painting Sections for surface preparation and paint application.

### 3.02 IDENTIFICATION SCHEDULE:

A. **Accessible Raceways and Cables within Buildings:** Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Standby Power.
   2. Power.
   3. UPS.

B. **Power-Circuit Conductor Identification, 600 V or Less:** For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   1. **Color-Coding for Phase Identification, 600 V or Less:** Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
b. Colors for 208/120-V Circuits:
   1) Phase A: Black.
   2) Phase B: Red.
   3) Phase C: Blue.

c. Colors for 480/277-V Circuits:
   1) Phase A: Brown.
   2) Phase B: Orange.
   3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches 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.

C. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

   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.

F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
G. **Workspace Indication:** Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

H. **Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:** Baked-enamel warning signs.

2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For 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.

I. **Operating Instruction Signs:** 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.

J. **Emergency Operating Instruction Signs:** Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer.

K. **Equipment Identification Labels:** On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the 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 high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches.
   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. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:
   
a. **Panelboards**: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchgear.

e. Switchboards.

f. **Transformers**: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

g. Substations.

h. Emergency system boxes and enclosures.

i. Motor-control centers.

j. Enclosed switches.

k. Enclosed circuit breakers.

l. Enclosed controllers.

m. Variable-speed controllers.

n. Push-button stations.

o. Power transfer equipment.

p. Contactors.

q. Remote-controlled switches, dimmer modules, and control devices.

r. Battery-inverter units.

s. Battery racks.

t. Power-generating units.
u. Monitoring and control equipment.
v. UPS equipment.

END OF SECTION
SECTION 16091 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS
AND CABLING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Sleeves for raceway and cable penetration of non-fire-rated
         construction walls and floors.
      2. Sleeve-seal systems.
      5. Silicone sealants.

1.03 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES:
   A. Wall Sleeves:
      1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B,
         Schedule 40, zinc coated, plain ends.
      2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to
         ductile-iron pressure pipe, with plain ends and integral waterstop
         unless otherwise indicated.
   B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board
      Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness;
      round tube closed with welded longitudinal joint, with tabs for screw-fastening
      the sleeve to the board.
   C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
   D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS:
   1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   2. 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. Advance Products & Systems, Inc. or pre-approved equal.
      b. CALPICO, Inc. or pre-approved equal.
      c. Metraflex Company (The). or pre-approved equal.
      d. Pipeline Seal and Insulator, Inc. or pre-approved equal.
      e. Proco Products, Inc. or pre-approved equal.
   3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   4. Pressure Plates: Carbon steel.
   5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS:
   A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
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. Presealed Systems or pre-approved equal.

2.04 GROUT:
A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS:
A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS:
A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION:

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
B. Install 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.

3.03 SLEEVE-SEAL-FITTING INSTALLATION:

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION
SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
B. Related Section: Section 16124 - MEDIUM-VOLTAGE CABLES for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.

1.03 DEFINITIONS:
A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.04 ACTION SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Product Data: For each type of product indicated.

1.05 INFORMATIONAL SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Field quality-control test reports.

1.06 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

2.01 CONDUCTORS AND CABLES:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alcan Products Corporation; Alcan Cable Division or pre-approved equal.
2. American Insulated Wire Corp.; a Leviton Company or pre-approved equal.
3. General Cable Corporation or pre-approved equal.
4. Senator Wire & Cable Company or pre-approved equal.
5. Southwire Company or pre-approved equal.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW THHN-THWN XHHW UF USE and SO.

D. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC metal-clad cable, Type MC mineral-insulated, metal-sheathed cable, Type MI nonmetallic-sheathed cable, Type NM Type SO and Type USE with ground wire.

2.02 CONNECTORS AND SPLICES:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1. AFC Cable Systems, Inc. or pre-approved equal.
2. Hubbell Power Systems, Inc. or pre-approved equal.
3. O-Z/Gedney; EGS Electrical Group LLC or pre-approved equal.
4. 3M; Electrical Products Division or pre-approved equal.
5. Tyco Electronics Corp. or pre-approved equal.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS:

A. **Feeders**: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. **Branch Circuits**: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS:

A. **Service Entrance**: Type THHN-THWN, 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. **Feeders Installed below Raised Flooring**: 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. **Branch Circuits Installed below Raised Flooring**: Type THHN-THWN, single conductors in raceway. Metal-clad cable, Type MC or similar UL listed assembly.

I. **Cord Drops and Portable Appliance Connections**: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

J. **Class 1 Control Circuits**: Type THHN-THWN, in raceway.

K. **Class 2 Control Circuits**: Type THHN-THWN, in raceway.

3.03 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 Section 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.

F. Identify and color-code conductors and cables according to Section 16075 - ELECTRICAL IDENTIFICATION.

3.04 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 486A and UL 486B.

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 6 inches of slack.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 16091 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING.

3.06 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 and feeder conductors for compliance with requirements.

3. **Infrared Scanning**: After Substantial Completion, but not less than 30 days or more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
   
   a. **Instrument**: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   
   b. **Record of Infrared Scanning**: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

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.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION
SECTION 16124 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. This Section includes cables and related splices, terminations, and
      accessories for medium-voltage electrical distribution systems.

1.03 DEFINITIONS:

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each type of cable indicated. Include splices and
      terminations for cables and cable accessories.
   C. Samples: 16-inch lengths of each type of cable indicated.

1.05 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Qualification Data: For Installer.
   C. Material Certificates: For each cable and accessory type, signed by
      manufacturers.
   D. Source quality-control test reports.
   E. Field quality-control test reports.

1.06 QUALITY ASSURANCE:
   A. Installer: Engage a cable splicer, trained and certified to install, splice, and
      terminate medium-voltage cable.
   B. 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 1910.7, and that is acceptable to authorities having jurisdiction.
   C. Source Limitations: Obtain cables and accessories through one source
      from a single manufacturer.
D. **Technical Specifications**: Medium-Voltage Cables

- **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.

E. Comply with IEEE C2 and NFPA 70.

1.07 **Project Conditions**:

A. **Interruption of Existing Electric Service**: Do not interrupt electric service to facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify University no fewer than seven days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without University’s written permission.

**PART 2 - Products**

2.01 **Manufacturers**:

A. **Available Manufacturers**: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. **Cables**:
   - a. American Insulated Wire Corp.; a Leviton Company or pre-approved equal.
   - b. General Cable Technologies Corporation or pre-approved equal.
   - c. Kerite Co. (The); Hubbell Incorporated or pre-approved equal.
   - d. Okonite Company (The) or pre-approved equal.
   - e. Pirelli Cables & Systems NA or pre-approved equal.
   - f. Rome Cable Corporation or pre-approved equal.
   - g. Southwire Company or pre-approved equal.

2. **Cable Splicing and Terminating Products and Accessories**:
   - a. Engineered Products Company or pre-approved equal.
   - b. G&W Electric Company or pre-approved equal.
   - c. MPHusky or pre-approved equal.
2.02 CABLES:

A. Cable Type: MV90 or MV105.
C. Conductor: Copper.
D. Conductor Stranding: Compact round, concentric lay, Class B.
E. Strand Filling: Conductor interstices are filled with impermeable compound.
F. Conductor Insulation: Crosslinked polyethylene.
   1. Voltage Rating: 15 kV.
   2. Insulation Thickness: 133 percent insulation level.
G. Shielding: Copper tape, helically applied over semiconducting insulation shield.
H. Cable Armor: Interlocked aluminum applied over cable.
I. Cable Jacket: Sunlight-resistant PVC.

2.03 SPLICE KITS:

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
1. Combination tape and cold-shrink-rubber sleeve kit with rejetacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.


4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.04 SOLID TERMINATIONS:

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.

2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

2.05 SEPARABLE INSULATED CONNECTORS:

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
E. **Test-Point Fault Indicators**: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

F. **Tool Set**: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

### 2.06 ARC-PROOFING MATERIALS:

A. **Tape for First Course on Metal Objects**: 10-mil-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. **Arc-Proofing Tape**: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket.

C. **Glass-Cloth Tape**: Pressure-sensitive adhesive type, 1/2 inch wide.

### 2.07 FAULT INDICATORS:

A. **Indicators**: Manually reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. **Resetting Tool**: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

### 2.08 SOURCE QUALITY CONTROL:

A. Test and inspect cables according to ICEA S-97-682 ICEA S-94-649 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

A. Install cables according to IEEE 576.

B. **Pull Conductors**: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

   1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.

E. Install direct-buried cables on leveled and tamped bed of 3-inch-thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried-cable" warning tape 12 inches above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits.

I. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

J. Install separable insulated-connector components as follows:
   1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
   1. Clean cable sheath.
   2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
   3. Smooth surface contours with electrical insulation putty.
   4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
   5. Band arc-proofing tape with 1-inch-wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.
L. Install fault indicators on each phase where indicated.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Identify cables according to SECTION 16075 - ELECTRICAL IDENTIFICATION.

3.02 FIELD QUALITY CONTROL:

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION
SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   5. Handholes and boxes for exterior underground cabling.

1.03 DEFINITIONS:
A. GRC: Galvanized rigid steel conduit.

1.04 ACTION SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.05 INFORMATIONAL SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
C. Qualification Data: For professional engineer.
D. **Seismic Qualification Certificates:** For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal 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.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

E. Source quality-control reports.

**PART 2 - PRODUCTS**

2.01 **METAL CONDUITS, TUBING, AND FITTINGS:**

A. **Listing and Labeling:** Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. **GRC:** Comply with ANSI C80.1 and UL 6.

C. **EMT:** Comply with ANSI C80.3 and UL 797.

D. **FMC:** Comply with UL 1; zinc-coated steel.

E. **LFMC:** Flexible steel conduit with PVC jacket and complying with UL 360.

F. **Fittings for Metal Conduit:** Comply with NEMA FB 1 and UL 514B.

1. **Fittings for EMT:**
   a. **Material:** Steel.
   b. **Type:** Setscrew.

2. **Expansion Fittings:** PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

G. **Joint Compound for GRC:** Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS:

A. **Listing and Labeling:** Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. **RNC:** Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. **LFNC:** Comply with UL 1660.

D. **Fittings for RNC:** Comply with NEMA TC 3; match to conduit or tubing type and material.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS:

A. **Description:** Sheet metal, complying with UL 870 and NEMA 250, Type 1 or 3R and Type 4X stainless steel unless otherwise indicated, and sized according to NFPA 70.

B. **Fittings and Accessories:** Include covers, 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.

C. **Wireway Covers:** Screw-cover type unless otherwise indicated.

D. **Finish:** Manufacturer’s standard enamel finish.

2.04 BOXES, ENCLOSURES, AND CABINETS:

A. **General Requirements for Boxes, Enclosures, and Cabinets:** Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. **Sheet Metal Outlet and Device Boxes:** Comply with NEMA OS 1 and UL 514A.

C. **Cast-Metal Outlet and Device Boxes:** Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.

D. **Luminaire Outlet Boxes:** Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

E. **Small Sheet Metal Pull and Junction Boxes:** NEMA OS 1.
F. **Cast-Metal Access, Pull, and Junction Boxes:** Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

H. **Device Box Dimensions:** 4 inches by 2-1/8 inches by 2-1/8 inches deep

I. **Hinged-Cover Enclosures:** Comply with UL 50 and NEMA 250, Type 1 or 3R and Type 4X stainless steel with continuous-hinge cover with flush latch unless otherwise indicated.
   1. **Metal Enclosures:** Steel, finished inside and out with manufacturer's standard enamel.
   2. **Interior Panels:** Steel; all sides finished with manufacturer's standard enamel.

J. **Cabinets:**
   1. NEMA 250, Type 1 or 3R and Type 4X stainless steel 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.

2.05 **HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING:**

A. **General Requirements for Handholes and Boxes:**
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. **Concrete Handholes Boxes and Cover:** See electrical details. Traffic rated where indicated.
   1. **Standard:** Comply with SCTE 77.
   2. **Configuration:** Designed for flush burial with open bottom unless otherwise indicated.
3. **Cover**: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

4. **Cover Finish**: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. **Cover Legend**: Molded lettering, "ELECTRIC" or "TELECOM"

6. **Conduit Entrance Provisions**: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

C. **Optional Polymer-Concrete Handholes and Boxes**: Submit substitution request of handholes and boxes molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass or a combination of the two; equivalent to specified concrete handholes and boxes.

### 2.06 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES:

A. **Handhole and Pull-Box Prototype Test**: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

### PART 3 - EXECUTION

#### 3.01 RACEWAY APPLICATION:

A. **Outdoors**: Apply raceway products as specified below unless otherwise indicated:

1. **Exposed Conduit**: GRC

2. **Concealed Conduit, Dry Aboveground Locations**: EMT

3. **Underground Conduit**: RNC, Type EPC-40-PVC. Concrete encased where indicated.
4. Connection to Vibrating Equipment (Including Transformers and
Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):
LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X stainless
steel.

B. Indoors: Apply raceway products as specified below unless otherwise
indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Physical Damage: GRC. Raceway locations
include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and
      pallet-handling units.
   c. Utility rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

4. Connection to Vibrating Equipment (Including Transformers and
Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):
FMC, except use LFMC in damp or wet locations.

5. Damp or Wet Locations: GRC.

6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250,
Type 3R in damp or wet locations.

C. Minimum Raceway Size: 1/2-inch (lighting); otherwise, 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and
location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless
otherwise indicated. Comply with NEMA FB 2.10.

2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.

3. Flexible Conduit: Use only fittings listed for use with flexible conduit.
Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120
deg F.
3.02 INSTALLATION:

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies.

B. Keep raceways at least 6 inches 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. Comply with requirements in SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by University for each specific location.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors.

M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

O. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Q. Exposed Raceways:
   1. Install exposed raceway with a minimum 2-inch radius control at bend points.
   2. Secure exposed raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions.

R. Install raceway sealing fittings at accessible locations according to NFPA 70 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 according to NFPA 70.

S. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.
T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

U. **Expansion-Joint Fittings:**

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

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 of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. **Flexible Conduit Connections:** Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

X. **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. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.03 INSTALLATION OF UNDERGROUND CONDUIT:

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as indicated.

2. Install backfill as indicated.

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 of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as indicated.

4. Install manufactured duct elbows for stub-ups at equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

B. Underground Warning Tape: Comply with requirements in SECTION 16075 - ELECTRICAL IDENTIFICATION.

3.04 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 sieve to No. 4 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 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 enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions where conduits do not enter through open bottom. 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.

3.05 **SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:**

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in SECTION 16091 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLELING.

3.06 **PROTECTION:**

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION
SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Receptacles, receptacles with integral GFCI, and associated device plates.
      2. Weather-resistant receptacles.
      3. Snap switches and wall-box dimmers.
      4. Wall-switch occupancy sensors.
      5. Communications outlets.

1.03 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.

1.04 ADMINISTRATIVE REQUIREMENTS:
   A. Coordination:
      1. Receptacles for University-Furnished Equipment: Match plug configurations.
      2. Cord and Plug Sets: Match equipment requirements.

1.05 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each type of product.
C. **Shop Drawings:** List of legends and description of materials and process used for premarking wall plates.

1.06 **INFORMATIONAL SUBMITTALS:**
   
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.

   B. Field quality-control reports.

1.07 **CLOSEOUT SUBMITTALS:**

   A. Submit in accordance with SECTION 01300 - SUBMITTALS.

   B. **Operation and Maintenance Data:** For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.08 **MAINTENANCE MATERIAL SUBMITTALS:**

   A. Submit in accordance with SECTION 01300 - SUBMITTALS.

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

**PART 2 - PRODUCTS**

2.01 **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; Division of Cooper Industries, Inc. (Cooper) or pre-approved equal.

      2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell) or pre-approved equal.

      3. Leviton Mfg. Company Inc. (Leviton) or pre-approved equal.

      4. Pass & Seymour/Legrand (Pass & Seymour) or pre-approved equal.

   B. **Source Limitations:** Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 **GENERAL WIRING-DEVICE REQUIREMENTS:**

   A. **Wiring Devices, Components, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   B. Comply with NFPA 70.
C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.

2. Devices shall comply with the requirements in this Section.

2.03 STRAIGHT-BLADE RECEPTACLES:

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper; 5351 (single), CR5362 (duplex) or pre-approved equal.
2. Hubbell; HBL5351 (single), HBL5352 (duplex) or pre-approved equal.
3. Leviton; 5891 (single), 5352 (duplex) or pre-approved equal.
4. Pass & Seymour; 5361 (single), 5362 (duplex) or pre-approved equal.


2.04 GFCI RECEPTACLES:

A. General Description:

1. Straight blade, feed-through type. Weather-resistant where indicated.

2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

C. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper; VGF20 or pre-approved equal.
2. Hubbell; GFR5352L or pre-approved equal.
3. Pass & Seymour; 2095 or pre-approved equal.
4. Leviton; 7590 or pre-approved equal.
2.05 **TOGGLE SWITCHES:**

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

C. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   1. **Single Pole:**
      a. Cooper; AH1221 or pre-approved equal.
      b. Hubbell; HBL1221 or pre-approved equal.
      c. Leviton; 1221-2 or pre-approved equal.
      d. Pass & Seymour; CSB20AC1 or pre-approved equal.

   2. **Three Way:**
      a. Cooper; AH1223 or pre-approved equal.
      b. Hubbell; HBL1223 or pre-approved equal.
      c. Leviton; 1223-2 or pre-approved equal.
      d. Pass & Seymour; CSB20AC3 or pre-approved equal.

2.06 **WALL PLATES:**

A. Single and combination types shall match corresponding wiring devices.

   1. **Plate-Securing Screws:** Metal with head color to match plate finish.
   
   2. **Material for Utility Chase:** Smooth, stainless steel.
   
   3. **Material for Finished Spaces:** Smooth, high-impact thermoplastic.
   
   4. **Material for Damp Locations:** Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. **Wet-Location, Weatherproof Cover Plates:** NEMA 250, complying with Type 3R, weather-resistant while in use, die-cast aluminum with lockable cover.

2.07 **PREFABRICATED MULTIOUTLET ASSEMBLIES:**

A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems or pre-approved equal.
2. Wiremold/Legrand or pre-approved equal.

B. **Description:**
   1. Two-piece surface metal raceway with outlets.
   2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. **Raceway Material:** Metal, with manufacturer's standard finish or PVC, as indicated.

D. **Multi-Outlet Harness:**
   1. **Receptacles:** 20-A, 125-V, NEMA WD 6 Configuration 5-20R duplex receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
   2. **Receptacle Spacing:** Receptacle quantity as indicated, evenly spaced beginning 12” from ends of raceway and 12” from edge of sink (no outlets above sink locations).
   3. **Wiring:** No. 12 AWG solid, Type THHN copper, circuiting as indicated.

E. **Device Color:**
   1. **Wiring Devices Connected to Normal Power System:** White unless otherwise indicated or required by NFPA 70 or device listing.

F. **Wall Plate Color:** For plastic covers, match device color.

**PART 3 - EXECUTION**

3.01 **INSTALLATION:**

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. **Coordination with Other Trades:**
   1. Protect installed devices and their boxes. 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 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 right 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 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that 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 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. 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 ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

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. **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.

3.02 **GFCI RECEPTACLES:**
   A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required. Provide weather-resistant GFCI receptacle for wet locations.

3.03 **IDENTIFICATION:**
   A. Comply with SECTION 16075 - ELECTRICAL IDENTIFICATION.
   B. Where specified, identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.04 **FIELD QUALITY CONTROL:**
   A. Perform the following tests and inspections:
      1. **Test Instrument for Convenience Receptacles:** Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
   B. **Tests for Convenience Receptacles:**
      1. Tests shall be diagnostic, indicating correct wiring, open ground, reverse polarity, open hot, open neutral, and hot/ground reversed.
      2. **GFCI Trip:** Test for tripping.
      3. Using the test plug, verify that the device and its outlet box are securely mounted.
      4. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
   A. Wiring device will be considered defective if it does not pass tests and inspections.
B. Prepare test and inspection reports.

END OF SECTION
SECTION 16145 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 GENERAL CONDITIONS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Time switches.
   2. Indoor occupancy sensors.
B. Related Requirements: SECTION 16140 - WIRING DEVICES for wall
   switch occupancy sensors, and manual light switches.

1.03 ACTION SUBMITTALS:
A. Submit in accordance with SECTION 01300 – SUBMITTALS.
B. Product Data: For each type of product.
C. Shop Drawings: Show installation details for occupancy and light-level
   sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.
B. Operation and Maintenance Data: For each type of lighting control device
   to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 TIME SWITCH CONTROL SYSTEM:
A. Manufacturers: Subject to compliance with requirements, manufacturers
   offering products that may be incorporated into the Work include, but are
   not limited to, the following:
B. **Basis-of-Design Product:** Subject to compliance with requirements, provide comparable product by one of the following: LC & D or pre-approved equal.

C. **Electronic Time Switch System:** Master-Slave system. Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, and marked for intended location and application.

2. **Contact Configuration:** SPST and DPST.

3. **Contact Rating:** 20-A ballast load

4. **Programs:** 32 channel; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.

5. **Circuitry:** Allow connection of a photoelectric relay as substitute for on-off function of a program.

6. System shall be compatible with installed BAS/BMS protocol.

7. System shall include digital outdoor photoelectric switch compatible with control system.

2.02 **INDOOR OCCUPANCY SENSORS:**

A. **Basis-of-Design Product:** Subject to compliance with requirements, provide or comparable product by one of the following:

1. Bryant Electric; a Hubbell company or pre-approved equal.

2. Cooper Industries, Inc. or pre-approved equal.

3. Hubbell Building Automation, Inc. or pre-approved equal.

4. Leviton Mfg. Company Inc. or pre-approved equal.

5. Lightolier Controls or pre-approved equal.

6. Lithonia Lighting; Acuity Lighting Group, Inc. or pre-approved equal.

7. Lutron Electronics Co., Inc. or pre-approved equal

8. NSi Industries LLC; TORK Products or pre-approved equal

9. RAB Lighting or pre-approved equal.

10. Sensor Switch, Inc. or pre-approved equal

11. Square D; a brand of Schneider Electric or pre-approved equal.
12. Watt Stopper or pre-approved equal.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

7. Bypass Switch: Override the "on" function in case of sensor failure.

8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc turn lights off when selected lighting level is present.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot high ceiling.
D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. **Detector Sensitivity:** Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

2. **Detection Coverage (Small Room):** Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch high ceiling.

3. **Detection Coverage (Standard Room):** Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

4. **Detection Coverage (Large Room):** Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.

5. **Detection Coverage (Corridor):** Detect occupancy anywhere within 90 feet when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet.

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. **Sensitivity Adjustment:** Separate for each sensing technology.

2. **Detector Sensitivity:** Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

3. **Detection Coverage (Standard Room):** Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

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**2.03 SWITCHBOX-MOUNTED OCCUPANCY SENSORS:**

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:

B. **Basis-of-Design Product:** Subject to compliance with requirements, provide or comparable product by one of the following:

1. Bryant Electric; a Hubbell company or pre-approved equal.
2. Cooper Industries, Inc. or pre-approved equal.
3. Hubbell Building Automation, Inc. or pre-approved equal.
4. Leviton Mfg. Company Inc. or pre-approved equal.
5. Lightolier Controls or pre-approved equal.
6. Lithonia Lighting; Acuity Lighting Group, Inc. or pre-approved equal.
7. Lutron Electronics Co., Inc. or pre-approved equal.
8. NSi Industries LLC; TORK Products or pre-approved equal.
9. RAB Lighting or pre-approved equal.
10. Sensor Switch, Inc. or pre-approved equal.
11. Square D; a brand of Schneider Electric or pre-approved equal.
12. Watt Stopper or pre-approved equal.

C. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

D. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: PIR, Dual technology - PIR and ultrasonic.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. **Adaptive Technology:** Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

PART 3 - EXECUTION

3.01 SENSOR INSTALLATION:

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 systems, and partition assemblies.

B. 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.

3.02 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.

3.03 WIRING INSTALLATION:

A. **Wiring Method:** Comply with SECTION 16120 - CONDUCTORS AND CABLES. Minimum conduit size is 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.

3.04 IDENTIFICATION:

A. Identify components and power and control wiring according to SECTION 16075 - ELECTRICAL IDENTIFICATION.

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.
3.05 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections.

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

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

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.06 ADJUSTING:

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit University's operations.

3.07 DEMONSTRATION:

A. University's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION
TECHNICAL SPECIFICATIONS
Packaged Trailer Mounted Engine Generators
Project No. SW-12-6238

SECTION 16230 - PACKAGED TRAILER MOUNTED ENGINE GENERATORS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. This Section includes: packaged trailer mounted engine-generator set for standby power supply with the following features:
      1. Diesel engine.
      2. Unit-mounted cooling system.
      3. Unit-mounted control and monitoring.
      4. Outdoor enclosure.

1.03 DEFINITIONS:
   A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 – SUBMITTALS.
   B. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
      1. Thermal damage curve for generator.
      2. Time-current characteristic curves for generator protective device.
   C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
      2. Detail fabrication, including anchorages and attachments to supported equipment. Include base weights.
1.05 INFORMATIONAL SUBMITTALS:

A. Submit in accordance with SECTION 01300 – SUBMITTALS

B. Qualification Data: For manufacturer.

C. Source quality-control test reports.

1. The generator set shall be designed, prototype tested, manufactured, factory tested and site tested per the requirements of NFPA 110 for Level 1 systems. Prototype qualification shall be accomplished by actual testing on assembled representative models of engine, alternator, cooling system, controls, and other system components. The manufacturer of the generator set shall provide certification of compliance to the requirements of NFPA 110 and a summary of prototype test work performed in the project submittals.

2. Report of certified factory test at 0.8 pf

3. Report of exhaust emissions showing compliance with applicable regulations. Tier 4 Certification.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

1.06 CLOSEOUT SUBMITTALS:

A. Submit in accordance with SECTION 01300 – SUBMITTALS

B. Operation and Maintenance Data: For packaged engine generators to include in operation and maintenance manuals. Include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.07 QUALITY ASSURANCE:

A. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. 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.
E. Comply with ASME B15.1.
F. Comply with NFPA 37.
G. Comply with NFPA 70.
H. Comply with UL 2200.
I. **Engine Exhaust Emissions:** Tier 4 EPA certification. Comply with applicable state and local government requirements.
J. **Noise Emission:** Sound pressure level of generator set shall not exceed 64dbA at 23 feet. Comply with applicable state and local government requirements for maximum noise level due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.08 **PROJECT CONDITIONS:**

A. **Environmental Conditions:** Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. **Ambient Temperature:** 5 to 40 deg C.
2. **Altitude:** Sea level to 5500 feet.

1.09 **WARRANTY:**

A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. **Warranty Period:** 2 year from date of Substantial Completion.

1.10 **MAINTENANCE SERVICE:**

A. **Initial Maintenance Service:** Beginning at substantial completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include Annual Full Service with oil and filter change. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work.

2.02 ENGINE-GENERATOR SET:

A. Factory-assembled and tested, Diesel engine-generator set shall provide 30KW at 0.8 power factor.

B. The Engine shall be rated by the engine manufacturer per ISO 8528 to provide necessary horsepower to deliver the required kW output, including all parasitic loads.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Voltage Regulation, no load to Full Load: Not more than 1 percent variation
2. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from.
3. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
4. Transient Frequency Performance: Less than 1 percent variation for 100 percent step-load increase or decrease.
5. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
6. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
7. The Voltage Regulation system shall be microprocessor controlled, 3-phase sensing, provide pulse-width modulated output and shall be full wave rectified. It shall include a permanent magnet generator for excitation system support.

2.03 ENGINE:

A. **Fuel:** Fuel oil, Grade DF-2.

B. **Rated Engine Speed:** 1800 rpm.

C. **Maximum Piston Speed for Four-Cycle Engines:** 2250 fpm.

D. **Lubrication System:** The following items are mounted on engine or skid:

   1. **Filter and Strainer:** Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

   2. **Thermostatic Control Valve:** Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

   3. **Crankcase Drain:** Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. **Engine Fuel System:**

   1. **Main Fuel Pump:** Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

F. Provide isochronous frequency regulation and voltage regulation not to exceed 1%.

G. **Cooling System:** Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

   1. **Coolant:** Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

   2. **Size of Radiator:** Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

   3. **Coolant:** Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

   4. **Temperature Control:** Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
H. **Muffler/Silencer**: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

I. **Air-Intake Filter**: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. **Starting System**: 12-V electric, with negative ground.
   1. **Components**: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. **Cranking Motor**: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. **Cranking Cycle**: 60 seconds.
   4. **Battery**: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
   5. **Battery Cable**: Size as recommended by battery and engine manufacturer. Include required interconnecting conductors and connection accessories.
   6. **Battery-Charging Alternator**: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

2.04 **FUEL OIL STORAGE**:

A. Comply with NFPA 30.

B. **Base-Mounted Fuel Oil Tank**: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
   1. Tank level indicator.
   2. **Capacity**: Fuel for eight hours' continuous operation at 100 percent rated power output.
   3. Vandal-resistant fill cap.
   4. **Containment Provisions**: Comply with requirements of authorities having jurisdiction.
2.05 **CONTROL AND MONITORING:**

A. **Manual Starting System Sequence of Operation**: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. **Configuration**: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. **Configuration**: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.

D. **Configuration**: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a unit mounted combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:

E. **Indicating and Protective Devices and Controls**:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Generator overload.

F. **Supporting Items:** Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

2.06 **GENERATOR OVERCURRENT AND FAULT PROTECTION:**

A. **Generator Circuit Breaker:** Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
   1. **Tripping Characteristic:** Designed specifically for generator protection.
   2. **Trip Rating:** Matched to generator rating.
   3. **Shunt Trip:** Connected to trip breaker when generator set is shut down by other protective devices.
   4. **Mounting:** Adjacent to or integrated with control and monitoring panel.

2.07 **GENERATOR, EXCITER, AND VOLTAGE REGULATOR**

A. Comply with NEMA MG 1.

B. **Drive:** Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

2.08 **Electrical Insulation:** Class H with maximum temperature rise of 105 degrees C over a 40 degree C environment. The sub transient reactance of the alternator based on the generator set rating shall not exceed 12%.

A. **Stator-Winding Leads:** Brought out to terminal box to permit future reconnection for other voltages if required.

B. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

C. **Enclosure:** Drip proof.

D. **Instrument Transformers:** Mounted within generator enclosure.

E. **Voltage Regulator:** Solid-state type, separate from exciter, providing performance as specified.
   1. 3 phase sensing, full wave rectified and pulse width modulated.
2.09 **OUTDOOR GENERATOR-SET ENCLOSURE:**

A. **Description:** Vandal-resistant, weather-protective Aluminum housing, wind resistant up to 150 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments and control shall be mounted within enclosure.

B. **Trailer:** Generator Trailer Tandem drop axles, 7,000 lbs total axle capacity. Multi-leaf spring suspension. Hydraulic braking system on both axles, Emergency break-away system. Hydraulic surge brake actuator with an adjustable height front channel and heavy duty bolt-on tow ring. Dual safety chains with hooks to meet D.O.T. Standards. Tongue Jack 5,000 lb capacity. Trailer wiring fully compliant with all local and state DOT regulations. Trailer Lighting shall comply with DOT standards.

2.10 **FINISHES:**

A. **Outdoor Enclosures and Components:** Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 **SOURCE QUALITY CONTROL:**

A. **Prototype Testing:** Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. **Tests:** Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. **Project-Specific Equipment Tests:** Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Full load run.

3. Maximum power.

4. Voltage regulation.

5. Transient and steady-state governing.


7. Safety shutdown.

8. Provide 14 days' advance notice of tests and opportunity for observation of tests by University's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

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

3.02 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification.

2. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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

G. Remove and replace malfunctioning units and retest as specified above.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
3.03 DEMONSTRATION:

A. Train University's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION
SECTION 16271 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. This Section includes the following types of transformers with medium-voltage primaries:
      1. Pad-mounted, liquid-filled transformers.

1.03 DEFINITIONS:

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

1.05 INFORMATIONAL SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Coordination Drawings: Floor 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. Underground primary and secondary conduit stub-up location.
      2. Dimensioned concrete base, outline of transformer, and required clearances.
      3. Ground rod and grounding cable locations.
   C. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in SECTION 16074 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS. Include the following:
      1. Basis for 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 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.

1.06 CLOSEOUT SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE:

A. Testing Agency Qualifications: An independent testing 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 1910.7, 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. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to SECTION 01600 - PRODUCT REQUIREMENTS - GENERAL.

C. 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.

D. Comply with IEEE C2.


F. Comply with NFPA 70.
1.08 DELIVERY, STORAGE, AND HANDLING:
A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer’s written instructions.

1.09 PROJECT CONDITIONS:
A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
   1. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.

1.10 COORDINATION:
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Acme Electric Corporation; Power Distribution Products Division or pre-approved equal.
   2. Cooper Industries; Cooper Power Systems Division or pre-approved equal.
   3. Cutler-Hammer or pre-approved equal.
   4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp or pre-approved equal.
   5. GE Electrical Distribution & Control or pre-approved equal.
   6. Hammond Manufacturing; Transformer Group or pre-approved equal.
   7. Kuhlman Electric Corporation or pre-approved equal.
   8. Pauwels Transformers or pre-approved equal.
   9. Pioneer Transformers or pre-approved equal.
   10. Siemens Energy & Automation, Inc or pre-approved equal.
   11. Square D; Schneider Electric or pre-approved equal.
2.02 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS:


B. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.

D. Basic Impulse Level: 30 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. High-Voltage Switch: High-Voltage Switch: 200 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for loop feed with 3-phase, 4-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.


H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed circuits.

I. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

1. Bushing-Well Inserts: One for each high-voltage bushing well.

2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
3. Parking Stands: One for each high-voltage bushing well.

J. Accessories:

1. Drain Valve: 1 inch, with sampling device.

2. Dial-type thermometer.

3. Liquid-level gage.

4. Pressure-vacuum gage.

5. Pressure Relief Device: Self-sealing with an indicator.

6. Alarm contacts for gages and thermometer listed above.

2.03 IDENTIFICATION DEVICES:

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in SECTION 16075 - ELECTRICAL IDENTIFICATION.

2.04 SOURCE QUALITY CONTROL:

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.

2. Ratios on rated-voltage connection and on tap extreme connections.


4. No-load loss at rated voltage on rated-voltage connection.

5. Excitation current at rated voltage on rated-voltage connection.

6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.


8. Induced potential.
9. **Temperature Test:** If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.

   a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

10. University will witness all required factory tests. Notify University at least 14 days before date of tests and indicate their approximate duration.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

   A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

   B. Examine roughing-in of conduits and grounding systems to verify the following:

      1. Wiring entries comply with layout requirements.

      2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

   C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

   D. Verify that ground connections are in place and that requirements in SECTION 16060 - GROUNDING AND BONDING have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.02 **INSTALLATION:**

   A. Install transformers on concrete bases.

      1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.

      2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.

4. Install epoxy-coated anchor bolts, for supported equipment, that anchor into concrete base.

5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.03 IDENTIFICATION:
A. Identify field-installed wiring and components and provide warning signs as specified in SECTION 16075 - ELECTRICAL IDENTIFICATION

3.04 CONNECTIONS:
A. Ground equipment according to SECTION 16060 - GROUNDING AND BONDING.
B. Connect wiring according to SECTION 16120 - CONDUCTORS AND CABLES.

3.05 FIELD QUALITY CONTROL:
A. Perform the following field tests and inspections and prepare test reports:
   1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
   2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Remove and replace malfunctioning units and retest as specified above.
C. Test Reports: Prepare written reports 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 actions taken to achieve compliance with requirements.

3.06 FOLLOW-UP SERVICE:

A. Voltage Monitoring and Adjusting: If requested by University, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by University, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.


END OF SECTION
SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
A. General: As specified in Section 01001.

1.02 SUMMARY:
A. Section Includes:
   1. Fusible switches.
   2. Nonfusable switches.
   3. Enclosures.

1.03 PERFORMANCE REQUIREMENTS:
A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

   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.

1.04 ACTION SUBMITTALS:
A. Submit in accordance with SECTION 01300 - SUBMITTALS.

   B. Product Data: For each type of enclosed switch, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

      1. Enclosure types and details for types other than NEMA 250, Type 1.
      2. Current and voltage ratings.
      3. Short-circuit current ratings (interrupting and withstand, as appropriate).
      4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

   C. Shop Drawings: For enclosed switches. Include plans, elevations, sections, details, and attachments to other work.
1.05  **INFORMATIONAL SUBMITTALS:**

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

   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.

1.06  **CLOSEOUT SUBMITTALS:**

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Operation and Maintenance Data: For enclosed switches to include in emergency, operation, and maintenance manuals.

1.07  **QUALITY ASSURANCE:**

A. Source Limitations: Obtain enclosed switches, devices, components, and accessories, within same product category, from single source from single manufacturer.

B. 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.

C. Comply with NFPA 70.

1.8  **COORDINATION:**

A. Coordinate layout and installation of switches and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**PART 2 - PRODUCTS**

2.01  **NONFUSIBLE SWITCHES:**

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work.
B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. 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; labeled for copper and aluminum neutral conductors.
   3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.02 ENCLOSURES:
A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 4X stainless steel.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.
B. Comply with mounting and anchoring requirements specified in Section 16074 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS. Install fuses in fusible devices.
C. Comply with NECA 1.
3.03 IDENTIFICATION:
   A. Comply with requirement in SECTION 16075 – ELECTRICAL IDENTIFICATION.
      1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
      2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL:
   A. Perform tests and inspections. Inspect components, assemblies, and equipment installations, including connections, and testing
      1. Tests and Inspections:
         a. Perform each visual and mechanical inspection and electrical test recommended by manufacturer. Comply with test parameters.
         b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
         c. Replace damaged and malfunctioning equipment.

   B. Prepare test and inspection reports, including a certified report that identifies enclosed switches. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING:
   A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION
SECTION 16442 - PANELBOARDS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Lighting and appliance branch-circuit panelboards.
      2. Electronic-grade panelboards.

1.03 DEFINITIONS:
   A. SVR: Suppressed voltage rating.
   B. TVSS: Transient voltage surge suppressor.

1.04 PERFORMANCE REQUIREMENTS:
   A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
      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."

1.05 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each type of panelboard, switching and 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.
   C. Shop Drawings: For each panelboard and related equipment.
      1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
      2. Detail enclosure types and details for types other than NEMA 250, Type 1.
      3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Include evidence of NRTL listing for series rating of installed devices.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include wiring diagrams for power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in SECTION 16074 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS. Include the following:

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.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Panelboard Schedules: For installation in panelboards.

1.07 CLOSEOUT SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 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 that allows adjustments.

1.08 MAINTENANCE MATERIAL SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. **Keys:** Two spares for each type of panelboard cabinet lock.

### 1.09 QUALITY ASSURANCE:

A. **Source Limitations:** Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. **Product Selection for Restricted Space:** Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. **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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

### 1.10 DELIVERY, STORAGE, AND HANDLING:

A. Remove loose packing and flammable materials from inside panelboards.

B. Handle and prepare panelboards for installation according to NECA 407.

### 1.11 PROJECT CONDITIONS:

A. **Environmental Limitations:**

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. **Ambient Temperature:** Not exceeding 50 deg F to plus 104 deg F.

   b. **Altitude:** Not exceeding 6600 feet.

B. **Service Conditions:**

1. **NEMA PB 1, usual service conditions, as follows:**

   a. Ambient temperatures within limits specified.

   b. Altitude not exceeding 6600 feet.
1.12 **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, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.13 **WARRANTY:**

A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. **Warranty Period:** One year from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.01 **GENERAL REQUIREMENTS FOR PANELBOARDS:**

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in SECTION 16074 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.

B. **Enclosures:** Flush- and surface-mounted cabinets, as indicated on plans.

1. Rated for environmental conditions at installed location.

   a. **Indoor Dry and Clean Locations:** NEMA 250, Type 1.

   b. **Outdoor Locations:** NEMA 250, Type 4X, stainless steel.

   c. **Other Wet or Damp Indoor Locations:** NEMA 250, Type 4X, stainless steel.

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. **Gutter Extension and Barrier:** Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
5. **Finishes:**
   a. **Panels and Trim:** galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. **Back Boxes:** Galvanized steel.
   c. **Fungus Proofing:** Permanent fungicidal treatment for overcurrent protective devices and other components.

6. **Directory Card:** Inside panelboard door, mounted in metal frame with transparent protective cover.

C. **Incoming Mains Location:** Top and bottom, as indicated on plans.

D. **Phase, Neutral, and Ground Buses:**
   1. **Material:** Hard-drawn copper, 98 percent conductivity.
   2. **Equipment Ground Bus:** Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. **Isolated Ground Bus:** Adequate for branch-circuit isolated ground conductors; insulated from box.
   4. **Extra-Capacity Neutral Bus:** Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
   5. **Split Bus:** Vertical buses divided into individual vertical sections.

E. **Conductor Connectors:** Suitable for use with conductor material and sizes.
   1. **Material:** Tin-plated aluminum.
   2. **Main and Neutral Lugs:** Mechanical type.
   3. **Ground Lugs and Bus-Configured Terminators:** Mechanical type.
   4. **Feed-Through Lugs:** Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   5. **Subfeed (Double) Lugs:** Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   6. **Gutter-Tap Lugs:** Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. **Extra-Capacity Neutral Lugs**: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. **Service Equipment Label**: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. **Future Devices**: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. **Panelboard Short-Circuit Current Rating**: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.02 **LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS**:

A. **Basis-of-Design Product**: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit or pre-approved equal.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution or pre-approved equal.

3. Siemens Energy & Automation, Inc. or pre-approved equal.

4. Square D; a brand of Schneider Electric or pre-approved equal.

B. **Panelboards**: NEMA PB 1, lighting and appliance branch-circuit type.

C. **Mains**: Circuit breaker or lugs only, as indicated on the plans.

D. **Branch Overcurrent Protective Devices**: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. **Contactors in Main Bus**: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. **Internal Control-Power Source**: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2. **External Control-Power Source**: 120-V branch circuit.

F. **Doors**: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. **Column-Type Panelboards**: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES:

A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit or pre-approved equal.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution or pre-approved equal.
3. Siemens Energy & Automation, Inc. or pre-approved equal.
4. Square D; a brand of Schneider Electric or pre-approved equal.

B. **Molded-Case Circuit Breaker (MCCB):** Comply with UL 489, 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 250 A and larger.
2. **Adjustable Instantaneous-Trip Circuit Breakers:** Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and 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; let-through ratings less than NEMA FU 1, RK-5.
5. **GFCI Circuit Breakers:** Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. **Ground-Fault Equipment Protection (GFEP) Circuit Breakers:** Class B ground-fault protection (30-mA trip).
7. **Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers:** Comply with UL 1699; 120/240-V, single-pole configuration.
8. **Molded-Case Circuit-Breaker (MCCB) Features and Accessories:**
a. Standard frame sizes, trip ratings, and number of poles.

b. **Lugs**: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

c. **Application Listing**: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. **Ground-Fault Protection**: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

e. **Communication Capability**: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control.

f. **Shunt Trip**: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

g. **Undervoltage Trip**: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

h. **Auxiliary Contacts**: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.

i. **Alarm Switch**: Single-pole, normally open contact that actuates only when circuit breaker trips.

j. **Key Interlock Kit**: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

k. **Zone-Selective Interlocking**: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.

l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

m. **Handle Padlocking Device**: Fixed attachment, for locking circuit-breaker handle in off position.

n. **Handle Clamp**: Loose attachment, for holding circuit-breaker handle in on position.

C. **Fused Switch**: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. **Fuses, and Spare-Fuse Cabinet**: Comply with requirements specified in Division 16 - ELECTRICAL.
2. **Fused Switch Features and Accessories:** Standard ampere ratings and number of poles.

3. **Auxiliary Contacts:** Two normally open and normally closed contact(s) that operate with switch handle operation.

### 2.04 PANELBOARD SUPPRESSORS:

A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation or pre-approved equal.

2. Eaton Electrical Inc.; Cutler-Hammer Business Unit or pre-approved equal.

3. General Electric Company; GE Consumer & Industrial - Electrical Distribution or pre-approved equal.

4. Liebert Corporation or pre-approved equal.

5. Siemens Energy & Automation, Inc. or pre-approved equal.

6. Square D; a brand of Schneider Electric or pre-approved equal.

B. **Surge Protection Device:** IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. **Accessories:**
   a. LED indicator lights for power and protection status.
   b. Audible alarm, with silencing switch, to indicate when protection has failed.
   c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

### 2.05 ACCESSORY COMPONENTS AND FEATURES:

A. **Accessory Set:** Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. **Portable Test Set:** For testing functions of solid-state trip devices, where provided, without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.
PART 3 - EXECUTION

3.01 EXAMINATION:

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION:

A. Install panelboards and accessories according to NECA 407.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Comply with mounting and anchoring requirements specified in SECTION 16074 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

J. Comply with NECA 1.
3.03 IDENTIFICATION:

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with SECTION 16075 - ELECTRICAL IDENTIFICATION.

B. Create a directory to indicate installed circuit loads; incorporate University's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in SECTION 16075 - ELECTRICAL IDENTIFICATION.

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in SECTION 16075 - ELECTRICAL IDENTIFICATION.

3.04 FIELD QUALITY CONTROL:

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

   b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. Panelboards will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3.05 **ADJUSTING:**

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

END OF SECTION
SECTION 16511 - INTERIOR LIGHTING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes:
      1. Interior lighting fixtures, lamps, and ballasts.
      2. Emergency lighting units.
      3. Exit signs.
      4. Lighting fixture supports.
   B. Related Sections:
      1. SECTION 16140 - WIRING DEVICES
      2. SECTION 16145 - LIGHTING CONTROL DEVICES for automatic control of lighting, including time switches, and occupancy sensors

1.03 DEFINITIONS:
   A. BF: Ballast factor.
   B. CCT: Correlated color temperature.
   C. CRI: Color-rendering index.
   D. HID: High-intensity discharge.
   E. LER: Luminaire efficacy rating.
   F. Lumen: Measured output of lamp and luminaire, or both.
   G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
      1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.

3. Ballast, including BF.


5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
   a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
   b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

C. Shop Drawings: For nonstandard or custom lighting fixtures. 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. Wiring Diagrams: For power, signal, and control wiring.

D. Installation instructions.

1.05 INFORMATIONAL SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Lighting fixtures.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
5. Structural members to which suspension systems for lighting fixtures will be attached.

6. Other items in finished ceiling including the following:
   a. Occupancy sensors.
   b. Access panels.

C. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers’ codes.

1.07 MAINTENANCE MATERIAL SUBMITTALS:

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

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.

4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.08 QUALITY ASSURANCE:
A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. 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.

C. Comply with NFPA 70.

1.09 COORDINATION:

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY:

A. Special Warranty for Emergency Lighting Batteries: Manufacturer’s standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.02 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS:

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
C. **Fluorescent Fixtures**: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. **Metal Parts**: Free of burrs and sharp corners and edges.

E. **Sheet Metal Components**: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. **Doors, Frames, and Other Internal Access**: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. **Diffusers and Globes**:
   1. **Acrylic Lighting Diffusers**: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. **Lens Thickness**: At least 0.125 inch minimum unless otherwise indicated.
      b. UV stabilized.
   2. **Glass**: Annealed crystal glass unless otherwise indicated.

H. **Factory-Applied Labels**: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. **Label** shall include the following lamp and ballast characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
      c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
      d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
      e. ANSI ballast type (M98, M57, etc.) for HID luminaires
      f. CCT and CRI for all luminaires.
I. **Electromagnetic-Interference Filters:** Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.03 **BALLASTS FOR LINEAR FLUORESCENT LAMPS:**

A. **General Requirements for Electronic Ballasts:**
   1. Comply with UL 935 and with ANSI C82.11.
   2. Designed for type and quantity of lamps served.
   3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
   4. **Sound Rating:** Class A
   5. **Total Harmonic Distortion Rating:** Less than 10 percent.
   6. **Transient Voltage Protection:** IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   7. **Operating Frequency:** 42 kHz or higher.
   8. **Lamp Current Crest Factor:** 1.7 or less.
   9. **BF:** 0.88 or higher as indicated.
   10. **Power Factor:** 0.95 or higher.
   11. **Parallel Lamp Circuits:** Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
   12. Ballasts shall be CEE certified high performance.

B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. **Electronic Programmed-Start Ballasts for T5, T8, T5HO Lamps:** Comply with ANSI C82.11 and the following:
   1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
   2. Automatic lamp starting after lamp replacement.

D. **Single Ballasts for Multiple Lighting Fixtures:** Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
E. **Ballasts for Low Electromagnetic-Interference Environments:** Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

F. **Ballasts for Bi-Level Controlled Lighting Fixtures:** Electronic type.

1. **Operating Modes:** Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
   
a. **High-Level Operation:** 100 percent of rated lamp lumens.
   
b. **Low-Level Operation:** 30 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.

3. **Compatibility:** Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.04 **BALLASTS FOR COMPACT FLUORESCENT LAMPS:**

A. **Description:** Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.

2. Automatic lamp starting after lamp replacement.

3. **Sound Rating:** Class A.

4. **Total Harmonic Distortion Rating:** Less than 20 percent.

5. **Transient Voltage Protection:** IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

6. **Operating Frequency:** 20 kHz or higher.

7. **Lamp Current Crest Factor:** 1.7 or less.

8. **BF:** 0.95 or higher unless otherwise indicated.

9. **Power Factor:** 0.95 or higher.

10. **Interference:** Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
2.05  EMERGENCY FLUORESCENT POWER UNIT:

A. **Internal Type:** Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. **Emergency Connection:** Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. **Nightlight Connection:** Operate one fluorescent lamp continuously.

3. **Test Push Button and Indicator Light:** Visible and accessible without opening fixture or entering ceiling space.
   a. **Push Button:** Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. **Indicator Light:** LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. **Battery:** Sealed, maintenance-free, nickel-cadmium type.

5. **Charger:** Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. **Integral Self-Test:** Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

B. **External Type:** Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. **Emergency Connection:** Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. **Nightlight Connection:** Operate one fluorescent lamp in a remote fixture continuously.

3. **Battery:** Sealed, maintenance-free, nickel-cadmium type.

4. **Charger:** Fully automatic, solid-state, constant-current type.

5. **Housing:** NEMA 250, Type 1 enclosure.

6. **Test Push Button:** Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. **LED Indicator Light**: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

8. **Integral Self-Test**: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

### 2.06 EXIT SIGNS:

A. **General Requirements for Exit Signs**: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. **Internally Lighted Signs**:

1. **Lamps for AC Operation**: LEDs, 50,000 hours minimum rated lamp life.

2. **Self-Powered Exit Signs (Battery Type)**: Integral automatic charger in a self-contained power pack.
   
   a. **Battery**: Sealed, maintenance-free, nickel-cadmium type.

   b. **Charger**: Fully automatic, solid-state type with sealed transfer relay.

   c. **Operation**: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

   d. **Test Push Button**: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

   e. **LED Indicator Light**: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

   f. **Integral Self-Test**: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

### 2.07 FLUORESCENT LAMPS:

A. **T8 rapid-start lamps**, rated 28 W maximum, nominal length of 48 inches, 2750 initial lumens (minimum), CRI 75 (minimum), color temperature 3000 K, and average rated life 20,000 hours unless otherwise indicated.
B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3000 K, and average rated life of 20,000 hours unless otherwise indicated.

C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3000 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.08 LIGHTING FIXTURE SUPPORT COMPONENTS:

A. Comply with SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Lighting fixtures:
1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by University, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.

   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

   4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:

   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.


   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

   4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Connect wiring according to SECTION 16120 - CONDUCTORS AND CABLES.
3.02 IDENTIFICATION:
   A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in SECTION 16075 - ELECTRICAL IDENTIFICATION.

3.03 FIELD QUALITY CONTROL:
   A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
   B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
   C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.04 STARTUP SERVICE:
   A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by University. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.05 ADJUSTING:
   A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
      1. Adjust aimable luminaires in the presence of University.

END OF SECTION
SECTION 16521 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS:
   A. General: As specified in Section 01001.

1.02 SUMMARY:
   A. Section Includes: Exterior luminaires with lamps and ballasts.
   B. Related Section: SECTION 16511 - INTERIOR LIGHTING for exterior luminaires normally mounted on exterior surfaces of buildings.

1.03 DEFINITIONS:
   A. CCT: Correlated color temperature.
   B. CRI: Color-rendering index.
   C. HID: High-intensity discharge.
   D. LER: Luminaire efficacy rating.
   E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.04 ACTION SUBMITTALS:
   A. Submit in accordance with SECTION 01300 - SUBMITTALS.
   B. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
      1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
      2. Details of attaching luminaires and accessories.
      3. Details of installation and construction.
      4. Luminaire materials.
      5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
         a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
6. Photoelectric relays.

7. Ballasts, including energy-efficiency data.

8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.


10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

1.05 INFORMATIONAL SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.06 MAINTENANCE MATERIAL SUBMITTALS:

A. Submit in accordance with SECTION 01300 - SUBMITTALS.

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

1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type.

2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 each type and rating installed. Furnish at least one of each type.

3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.07 QUALITY ASSURANCE:

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers’ laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
C. **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.


E. Comply with NFPA 70.

1.08 **WARRANTY:**

   A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

   1. **Warranty Period for Luminaires:** Five years from date of Substantial Completion. The Surety shall not be liable beyond 2 years of the project acceptance date.

   2. **Warranty Period for Metal Corrosion:** Five years from date of Substantial Completion. The Surety shall not be liable beyond 2 years of the project acceptance date.

   3. **Warranty Period for Color Retention:** Five years from date of Substantial Completion. The Surety shall not be liable beyond 2 years of the project acceptance date.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURERS:**

   A. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.02 **GENERAL REQUIREMENTS FOR LUMINAIRES:**

   A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

   1. **LER Tests Incandescent Fixtures:** Where LER is specified, test according to NEMA LE 5A.

   2. **LER Tests Fluorescent Fixtures:** Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

   3. **LER Tests HID Fixtures:** Where LER is specified, test according to NEMA LE 5B.
B. **Lateral Light Distribution Patterns**: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. **Metal Parts**: Free of burrs and sharp corners and edges.

D. **Sheet Metal Components**: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. **Housings**: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. **Doors, Frames, and Other Internal Access**: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. **Exposed Hardware Material**: Stainless steel.

H. **Plastic Parts**: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. **Light Shields**: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. **White Surfaces**: 85 percent.
2. **Specular Surfaces**: 83 percent.
3. **Diffusing Specular Surfaces**: 75 percent.

K. **Lenses and Refractors Gaskets**: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. **Luminaire Finish**: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. **Factory-Applied Finish for Steel Luminaires**: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. **Surface Preparation:** Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. **Exterior Surfaces:** Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   
   a. **Color:** As selected by University from manufacturer's full range.

N. **Factory-Applied Finish for Aluminum Luminaires:** Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. **Natural Satin Finish:** Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

3. **Class I, Clear Anodic Finish:** AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. **Class I, Color Anodic Finish:** AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
   
   a. **Color:** as noted on drawings.

O. **Factory-Applied Labels:** Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. **Label shall include the following lamp and ballast characteristics:**
   
   a. "USES ONLY" and include specific lamp type.

   b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.

e. ANSI ballast type (M98, M57, etc.) for HID luminaires.

f. CCT and CRI for all luminaires.

2.03 BALLASTS FOR HID LAMPS:

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).


4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

C. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.

   a. Restrike Range: 105- to 130-V ac.

   b. Maximum Voltage: 250-V peak or 150-V ac rms.

2. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION:

A. Install lamps in each luminaire.
B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.02 CORROSION PREVENTION:
   A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
   
   B. Steel Conduits: Comply with SECTION 16130 - RACEWAYS AND BOXES. In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.03 GROUNDING:
   A. Ground metal poles and support structures according to SECTION 16060 - GROUNDING AND BONDING.
      1. Install grounding electrode for each pole unless otherwise indicated.
      2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

   B. Ground nonmetallic poles and support structures according to SECTION 16060 - GROUNDING AND BONDING.
      1. Install grounding electrode for each pole.
      2. Install grounding conductor and conductor protector.
      3. Ground metallic components of pole accessories and foundations.

3.04 FIELD QUALITY CONTROL:
   A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

   B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
      1. Verify operation of photoelectric controls.

   C. Illumination Tests:
      1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):


c. ESNA LM-64, "Photometric Measurements of Parking Areas."

d. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION
FOUNDATION INVESTIGATION
VET TECH FACILITY
WINDWARD COMMUNITY COLLEGE
KANEHOHE, HAWAII
UH PROJECT NO. SW-12-6238

for

SHIMOKAWA + NAKAMURA, INC.
March 1, 2012
W.O. 12-5272

Mr. Jeffery S. Nakamura
Shimokawa + Nakamura, Inc.
1580 Makaloa Street, Suite 1050
Honolulu, Hawaii, 96814

Dear Mr. Nakamura:

Our report, "Foundation Investigation, Vet Tech Facility, Windward Community College, Kaneohe, Hawaii," dated March 1, 2012, our Work Order 12-5272 is enclosed. This investigation was conducted in general conformance with the scope of services presented in our proposal dated September 15, 2011.

Our borings encountered surface and near surface soils consisting of brown clayey silt and fill material consisting of the native clayey silt mixed with coral and basalt gravel. Laboratory testing on the clayey silt indicated that the soil has a low expansion potential when tested near its in-situ moisture content. Typical of soils in the Kaneohe area, the clayey silt was very moist with moisture contents generally ranging from about 40 to 60 percent. Based on our past experience in the project area, the expansion potential of the clayey silt increases when the soil is allowed to dry. The Soil Survey, prepared by the U.S. Soil Conservation Service, describes the soil in the project area as having a low to moderate expansion potential.

Conventional shallow foundations may be used to support the proposed structure. However, due to the low to moderate expansion potential of the onsite clayey silt, and to provide more uniform support, we recommend that all footings and concrete slabs-on-grade be underlain by a minimum 12 inches of imported granular structural fill.

The following is a summary of our geotechnical recommendations. This summary is not intended to be a substitute for our report which includes more detailed explanations of our recommendations, as well as additional requirements.

- Allowable bearing value = 2,500 psf
- Coefficient of friction = 0.4
- Passive earth pressure = 300 pcf

We appreciate this opportunity to be of service. Should you have any questions concerning this report, please feel free to call on us.

Very truly yours,

HIRATA & ASSOCIATES, INC.

[Signature]
Paul S. Morimoto President

PSM: SJ
TABLE OF CONTENTS

INTRODUCTION ......................................................... 1
PROJECT CONSIDERATIONS ........................................... 2
SITE CONDITIONS ......................................................... 2
SOIL CONDITIONS ......................................................... 3
CONCLUSIONS AND RECOMMENDATIONS

  Foundations ......................................................... 4
  Seismic Design ....................................................... 5
  Lateral Design ....................................................... 6
  Foundation Settlement .............................................. 6
  Slabs-on Grade ...................................................... 6
  Site Grading ......................................................... 7

ADDITIONAL SERVICES ................................................. 9
LIMITATIONS ............................................................. 9
APPENDICES

APPENDIX A

Description of Field Investigation ......................... Plates A1.1 and A1.2
Location Map ............................................. Plate A2.1
Boring Location Plan ....................................... Plate A2.2
Boring Log Legend .......................................... Plate A3.1
Unified Soil Classification System ......................... Plate A3.2
Boring Logs ................................................ Plates A4.1 and A4.2

APPENDIX B

Description of Laboratory Testing ......................... Plates B1.1 and B1.2
Consolidation Test Reports ................................ Plates B2.1 through B2.3
Direct Shear Test Reports ................................ Plates B3.1 and B3.2
Proctor Test Report ......................................... Plate B4.1
INTRODUCTION

This report presents the results of our foundation investigation performed for the proposed Vet Tech Facility at Windward Community College in Kaneohe, Hawaii. Our scope of services for this study included the following:

- A visual reconnaissance of the site to observe existing conditions which may affect the project. The general location of the project site is shown on the enclosed Location Map, Plate A2.1.

- A review of available in-house soils information pertinent to the site and the proposed project.

- Drilling and sampling two exploratory borings to depths of about 14.5 and 15.5 feet below existing grade. A description of our field investigation is summarized on Plates A1.1 and A1.2. The approximate exploratory boring locations are shown on the enclosed Boring Location Plan, Plate A2.2, and the soils encountered in the borings are described on the Boring Logs, Plates A4.1 and A4.2.

- Laboratory testing of selected soil samples. Testing procedures are presented in the Description of Laboratory Testing, Plates B1.1 and B1.2. Test results are presented in the Description of Laboratory Testing, and on the Unified Soil Classification System Chart (Plate A3.2), Boring Logs (Plates A4.1 and A4.2), Consolidation Test reports (Plates B2.1 through B2.3), Direct Shear Test reports (Plates B3.1 and B3.2), and Modified Proctor Test report (Plate B4.1).

- Engineering analyses of the field and laboratory data.
• Preparation of this report presenting geotechnical recommendations for the
design of foundations, including seismic considerations, concrete slabs-on-
grade, resistance to lateral pressures, and site grading.

PROJECT CONSIDERATIONS

Information regarding the proposed project was provided by personnel from your office.

The proposed facility will consist of a single story structure with a footprint area on the order of 1,969 square feet. The structure will have 8 separate areas consisting of animal treatment, dog holding, cat holding, surgery, radiology, dark room, laundry/cleaning, and a dry storage area. Structural loads were not available at the time of this report, however, we assume that the main facility will utilize reinforced concrete and/or masonry wall construction, with concrete slabs-on-grade.

Although finish grades were not available at the time of this report, we assume that only minor site grading work will be required.

SITE CONDITIONS

Windward Community College is located on the west side of Kahekili Highway, southwest of its intersection with Kcaahala Road in Kaneohe, Hawaii. The project site is located in the northern portion of the campus, on the north side of Hale Imiloa.

The site is currently occupied by several structures and AC paved areas. The structures include a cooling tower, propane tank, and sump box. The project site is relatively level. Drainage generally flows in a northeasterly direction with ground elevations ranging from about +218 in the northeast to about +220 in the southwest.

SOIL CONDITIONS

Boring B2 was drilled through the existing pavement which consisted of about 2 inches of AC over about 5 inches of base material. Beneath the pavement section in
boring B2 was fill consisting of the native brown clayey silt mixed with coral and basalt gravel. The fill material was in a medium stiff condition, and extended to a depth of about 8.5 feet. A 6-inch layer of gray sand was encountered below the fill material.

Underlying the sand in boring B2 and at ground surface in boring B1 was brown clayey silt. The clayey silt was in a stiff condition and extended to the maximum depths drilled. Laboratory testing on the clayey silt indicated a low expansion potential when tested near its in-situ moisture content. Typical of soils in the Kaneohe area, the clayey silt was very moist with moisture contents generally ranging from about 40 to 60 percent. Based on our past experience in the project area, the expansion potential of the clayey silt increases when the soil is allowed to dry. The Soil Survey, prepared by the U.S. Soil Conservation Service, describes the soil in the project area as having a low to moderate expansion potential.

Neither groundwater nor seepage water was encountered in the borings.
CONCLUSIONS AND RECOMMENDATIONS

Conventional shallow foundations may be used to support the proposed structure. However, due to the low to moderate expansion potential of the onsite clayey silt and to provide more uniform support, we recommend that all footings and concrete slabs-on-grade be underlain by a minimum 12 inches of imported granular fill. The standard 4-inch gravel cushion below concrete slabs-on-grade may be considered part of the granular fill section. The remainder of the fill should consist of imported granular structural fill.

Prior to placement of imported granular structural fill, the onsite clayey silt should be thoroughly compacted. We believe that achieving the usual 90 percent compaction standard as determined by ASTM D 1557 may be difficult due to the relatively high insitu moisture content of the clayey silt. Therefore, as an alternative to the usual compaction requirement, an alternate compaction requirement may be specified to facilitate site grading.

The alternate compaction requirement consists of compacting the onsite soils to a minimum 100 percent of the maximum wet density determined for the soil at its insitu moisture content, using ASTM D 1557 procedures. It has been our experience that achieving this compaction requirement will require approximately the same compaction effort to compact a normal clayey silt to between 90 and 95 percent compaction as determined by ASTM D 1557.

Foundations

Conventional shallow foundations, such as spread footings or thickened slab foundations, founded on a minimum 12 inches of imported granular structural fill may be used to support the proposed structure. To avoid undermining the existing foundations, lateral overexcavations adjacent to existing foundations will not be required. Imported granular structural fill should conform to and be placed in
accordance with recommendations presented in the Site Grading section of this report.

In areas where granular structural fill is placed outside the building area and is open to the environment, we recommend that the granular material be capped with a minimum 12 inches of low permeability soil, such as the onsite clayey silt. The clayey silt capping layer should be compacted in lifts to a minimum 100 percent of the maximum wet density determined for the soil at its insitu moisture content, using ASTM D 1557 procedures.

Foundations may be designed for an allowable bearing value of 2,500 pounds per square foot. The recommended allowable bearing value is for the total of dead and frequently applied live loads and may be increased by one-third for short duration loading which includes the effects of wind and seismic forces.

Spread footings should be a minimum 16 inches in width; thickened slab foundations should be a minimum 12 inches wide. All foundations should be embedded at least 12 inches below finish adjacent grade. The bottom of all footing excavations should be thoroughly tamped and cleaned of loose material prior to placement of reinforcing steel and concrete.

To avoid imposing additional loads on existing foundations, foundations for the new structure located adjacent to the existing building should be founded at approximately the same elevation as that of the existing footings.

**Seismic Design**

Based on the borings drilled as part of this study and our knowledge of the deep soil conditions in the area, the subsurface soils can be characterized as a stiff soil profile.
Therefore, based on the 2003 International Building Code, Site Class D is recommended for this site.

**Lateral Design**
Resistance to lateral loading may be provided by friction acting at the base of foundations, and by passive earth pressure acting on the buried portions of foundations.

A coefficient of friction of 0.4 may be used with the dead load forces. Passive earth pressure may be computed as an equivalent fluid having a density of 300 pounds per cubic foot with a maximum earth pressure of 3,000 pounds per square foot. Unless covered by pavement or concrete slabs, the upper 12 inches of soil should not be considered in computing lateral resistance.

For active earth pressure considerations, equivalent fluid pressures of 40 and 55 pounds per cubic foot may be used for freestanding and restrained or at-rest conditions, respectively. To prevent buildup of hydrostatic pressures, weepholes or subdrains should be included in the design of all retaining structures.

**Foundation Settlement**
Although structural loads were not available at the time of this report, based on the medium stiff to stiff condition of the onsite soils and the relatively light building loads expected, excessive total and differential settlements are not anticipated.

**Slabs-on-Grade**
All building slabs-on-grade should be underlain by a minimum 12 inches of imported granular fill. The upper 4 inches of the granular fill should consist of a cushion of clean gravel, such as #3 Fine (ASTM C33, Size No. 67). The remainder of the granular fill section should consist of imported granular structural fill. See the *Site*
Grading section of this report for imported granular structural fill requirements. Building slabs should also be protected by a vapor barrier.

Prior to placement of granular fill, the clayey silt subgrade should be scarified to a depth of 6 inches, moisture conditioned if necessary to about 2 percent above the optimum moisture content, and compacted to between 90 and 95 percent compaction as determined by ASTM D 1557, or to a minimum 100 percent of the maximum wet density determined for the soil at its insitu moisture content, using ASTM D 1557 procedures. The granular structural fill should be compacted in lifts, to a minimum 95 percent compaction as determined by ASTM D 1557. The gravel cushion should be compacted to a level surface using a vibratory compactor.

Site Grading

Site Preparation - The project site should be cleared of all vegetation and other deleterious material. In areas requiring fill placement, the exposed subgrade should be scarified to a minimum depth of 6 inches, moisture conditioned to about 2 percent above optimum moisture content, and compacted to between 90 and 95 percent compaction as determined by ASTM D 1557.

The moisture content of the in-situ clayey silt is significantly higher than the optimum moisture content as determined by ASTM D 1557. As a result, it may be difficult to achieve the recommended compaction requirements during subgrade preparation. Therefore, as an alternative, a compaction requirement consisting of compacting the onsite clayey silt to a minimum 100 percent of the maximum wet density determined for the soil at its in-situ moisture content, may be used to facilitate site grading.

It has been our experience that achieving this compaction requirement will require approximately the same compaction effort as compacting a normal clayey silt to between 90 and 95 percent compaction as determined by ASTM D 1557.
Onsite Fill Material - The onsite clayey silt will be acceptable for reuse as compacted fill, except in the imported granular fill section recommended below footings and slabs-on-grade. All rock fragments larger than 3 inches in maximum dimension should be removed from the onsite clayey silt prior to reuse. Air drying of the soil may also be required to reduce the insitu moisture content to slightly above the optimum moisture content.

Imported Fill Material - Imported structural fill should be well-graded, non-expansive granular material. Specifications for imported granular structural fill should indicate a maximum particle size of 3 inches, and state that between 8 and 20 percent of soil by weight shall pass the #200 sieve. In addition, the plasticity index (P.I.) of that portion of the soil passing the #40 sieve shall not be greater than 10. Granular structural fill should also have a minimum CBR value of 15 and a CBR expansion value less than 1.0 percent when tested in accordance with ASTM D 1883.

Compaction - The onsite clayey silt should be moisture conditioned to at least 2 percent above optimum moisture content, placed in horizontal lifts restricted to eight inches in loose thickness and compacted to between 90 and 95 percent compaction as determined by ASTM D 1557. Granular soils, such as imported granular structural fill, should also be placed in horizontal lifts restricted to eight inches in loose thickness, but should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Structural Excavations - Based on our exploratory borings, we believe that excavations into the onsite clayey silt can generally be accomplished using conventional excavating equipment.
Temporary shallow cuts into the near surface soils should be stable at slope gradients of 1H:1V or flatter. However, it should be the Contractor's responsibility to conform to all OSHA safety standards for excavations.

ADDITIONAL SERVICES

We recommend that we perform a general review of the final design plans and specifications. This will allow us to verify that the foundation design and earthwork recommendations have been properly interpreted and implemented in the design plans and construction specifications.

For continuity, we recommend that we be retained during construction to (1) observe footing excavations prior to placement of granular structural fill, reinforcing steel and concrete, (2) review and/or perform laboratory testing on import borrow to determine its acceptability for use in compacted fills, (3) observe structural fill placement and perform compaction testing, and (4) provide geotechnical consultation as required. Our services during construction will allow us to verify that our recommendations are properly interpreted and included in construction, and if necessary, to make modifications to those recommendations, thereby reducing construction delays in the event subsurface conditions differ from those anticipated.

LIMITATIONS

The boring logs indicate the approximate subsurface soil conditions encountered only at those times and locations where our borings were made, and may not represent conditions at other times and locations.

This report was prepared specifically for Shimokawa + Nakamura Inc. and their sub-consultants for design of the proposed Vet Tech Facility at Windward Community College in Kaneohe, Hawaii. The boring logs, laboratory test results, and recommendations presented in this report are for evaluation and design purposes
only, and are not intended for use in developing cost estimates by the contractor. During construction, should subsurface conditions differ from those encountered in our borings, we should be advised immediately in order to re-evaluate our recommendations, and to revise or verify them in writing before proceeding with construction.

Our recommendations and conclusions are based upon the site materials observed, the preliminary design information made available, the data obtained from our site exploration, our engineering analyses, and our experience and engineering judgement. The conclusions and recommendations in this report are professional opinions which we have strived to develop in a manner consistent with that level of care, skill, and competence ordinarily exercised by members of the profession in good standing, currently practicing under similar conditions in the same locality. We will be responsible for those recommendations and conclusions, but will not be responsible for the interpretation by others of the information developed. No warranty is made regarding the services performed, either express or implied.

Respectfully submitted,

HIRATA & ASSOCIATES, INC.

Stephen Jo, Project Engineer

Rick Yoshida, Project Manager

This work was prepared by me or under my supervision
Expiryation Date of License: April 30, 2012
APPENDIX A

FIELD INVESTIGATION
DESCRIPTION OF FIELD INVESTIGATION

GENERAL

The site was explored on January 16, 2012, by performing a visual reconnaissance of the site and drilling two test borings to depths of about 14.5 and 15.5 feet with a Mobile B80 truck-mounted drill rig.

During drilling operations, the soils were continuously logged by our field engineer and classified by visual examination in accordance with the Unified Soil Classification System. The boring logs indicate the depths at which the soils or their characteristics change, although the change could actually be gradual. If the change occurred between sample locations, the depth was interpreted based on field observations. Classifications and sampling intervals are shown on the boring logs. A Boring Log Legend is presented on Plate A3.1. The Unified Soil Classification System is shown on Plate A3.2. The soils encountered are logged on Plates A4.1 and A4.2.

The borings were located in the field by measuring/taping offsets from existing site features shown on the plans. Surface elevations at boring locations were estimated based on the Topographic Survey Map provided by Shimokawa + Nakamura, Inc. The accuracy of the boring locations shown on Plate A2.2 and the boring elevations shown on Plates A4.1 and A4.2 are therefore approximate, in accordance with the field methods used.

SOIL SAMPLING

Representative and bulk soil samples were recovered from the borings for selected laboratory testing and analyses. Representative samples were recovered by driving a 3-inch O.D. split tube sampler a total of 18 inches with a 140-pound hammer dropped from a height of 30 inches. The number of blows required to drive the
sampler the final 12 inches are recorded at the appropriate depths on the boring logs, unless noted otherwise. A bulk soil sample was recovered from near boring B1 at a depth of about 1.5 feet below ground surface.
<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>GROUP SYMBOLS</th>
<th>TYPICAL NAMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>COARSE GRAINED SOILS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(More than 50% of the material is LARGER than No. 200 sieve size.)</td>
<td>CLEAN GRAVELS (Little or no fines.)</td>
<td>Well graded gravels, gravel-sand mixtures, little or no fines.</td>
</tr>
<tr>
<td></td>
<td>GRAVELS WITH FINES (Appreciable amt. of fines.)</td>
<td>Poorly graded gravels or gravel-sand mixtures, little or no fines.</td>
</tr>
<tr>
<td></td>
<td>SANDS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size.)</td>
<td>Silty gravels, gravel-sand-silt mixtures.</td>
</tr>
<tr>
<td></td>
<td>SANDS WITH FINES (Appreciable amt. of fines.)</td>
<td>Clayey gravels, gravel-sand-clay mixtures.</td>
</tr>
<tr>
<td>FINE GRAINED SOILS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(More than 50% of the material is SMALLER than No. 200 sieve size.)</td>
<td>SILTS AND CLAYS (Liquid limit LESS than 50.)</td>
<td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.</td>
</tr>
<tr>
<td></td>
<td>SILTS AND CLAYS (Liquid limit GREATER than 50.)</td>
<td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.</td>
</tr>
<tr>
<td>HIGHLY ORGANIC SOILS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VOLCANIC TUFF / HIGHLY TO COMPLETELY WEATHERED BASALT</td>
<td>Inorganic clays of high plasticity, fat clays.</td>
</tr>
<tr>
<td></td>
<td>FRESH TO MODERATELY WEATHERED BASALT</td>
<td>Organic clays of medium to high plasticity, organic silts.</td>
</tr>
</tbody>
</table>

SAMPLE DEFINITION

- 2" O.D. Standard Split Spoon Sampler
- 3" O.D. Split Tube Sampler
- Shelby Tube
- NX / 4" Coring
- Water Level

W.O. 12-5272

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BORING LOG LEGEND

Plate A3.1
**PLASTICITY CHART**

Liquid Limit

<table>
<thead>
<tr>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>ML-CL</td>
</tr>
<tr>
<td>ML &amp; OL</td>
</tr>
<tr>
<td>CL</td>
</tr>
<tr>
<td>MH &amp; OH</td>
</tr>
<tr>
<td>CH</td>
</tr>
<tr>
<td>A-Line</td>
</tr>
</tbody>
</table>

**LEGEND:**
- Boring B1 at 1.5 feet

---

**GRADATION CHART**

**COMPONENT DEFINITIONS BY GRADATION**

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>SIZE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Above 12 in.</td>
</tr>
<tr>
<td>Cobbles</td>
<td>3 in. to 12 in.</td>
</tr>
<tr>
<td>Gravel</td>
<td>3 in. to No. 4 (4.76 mm)</td>
</tr>
<tr>
<td>Coarse gravel</td>
<td>3 in. to 3/4 in.</td>
</tr>
<tr>
<td>Fine gravel</td>
<td>3/4 in. to No. 4 (4.76 mm)</td>
</tr>
<tr>
<td>Sand</td>
<td>No. 4 (4.76 mm) to No. 200 (0.074 mm)</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>No. 4 (4.76 mm) to No. 10 (2.0 mm)</td>
</tr>
<tr>
<td>Medium sand</td>
<td>No. 10 (2.0 mm) to No. 40 (0.42 mm)</td>
</tr>
<tr>
<td>Fine sand</td>
<td>No. 40 (0.42 mm) to No. 200 (0.074 mm)</td>
</tr>
<tr>
<td>Silt and clay</td>
<td>Smaller than No. 200 (0.074 mm)</td>
</tr>
</tbody>
</table>

---

W.O. 12-5272  Vet Tech Facility - Windward Community College

Hirata & Associates, Inc.  UNIFIED SOIL CLASSIFICATION SYSTEM

Plate A3.2
<table>
<thead>
<tr>
<th>DEPTH</th>
<th>GRAPH</th>
<th>SAMPLE</th>
<th>BLOWS PER FOOT</th>
<th>DRY DENSITY (PCF)</th>
<th>MOIST. CONT. (%)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>60</td>
<td>68</td>
<td>50</td>
<td>Clayey Silt (MH) — Brown, moist, stiff. With gravel at 0.5 feet.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>60</td>
<td>65</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>37</td>
<td>66</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td>41</td>
<td>59</td>
<td>54</td>
<td>End boring at 15.5 feet.</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td>42</td>
<td>60</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Elevations based on Topographic Survey Map provided by Shimakawa + Nakamura, Inc.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample</th>
<th>Blows Per Foot</th>
<th>Dry Density (PCF)</th>
<th>Moist. Cont. (%)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>12</td>
<td>68</td>
<td>37</td>
<td>Clayey Silt (MH) – Brown, moist, medium stiff, with coral and basalt gravel. (Fill)</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>12</td>
<td>67</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>9/6&quot;</td>
<td>14</td>
<td>66</td>
<td>58</td>
<td>Sand from 8.5 to 9 feet.</td>
</tr>
<tr>
<td>-15</td>
<td>29</td>
<td>61</td>
<td>56</td>
<td></td>
<td>Clayey Silt (MH) – Brown, moist, stiff.</td>
</tr>
<tr>
<td>-15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>End boring at 14.5 feet.</td>
</tr>
<tr>
<td>-20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Neither groundwater nor seepage water encountered.</td>
</tr>
</tbody>
</table>
DESCRIPTION OF LABORATORY TESTING

CLASSIFICATION
Field classification was verified in the laboratory in accordance with the Unified Soil Classification System. Laboratory classification was determined by both visual examination and Atterberg Limit tests performed in general accordance with ASTM D 4318. Results of Atterberg Limit tests are plotted on Plate A3.2. The final classifications are shown at the appropriate locations on the Boring Logs, Plates A4.1 and A4.2.

MOISTURE-DENSITY
Representative samples were tested for field moisture content and dry unit weight. The dry unit weight was determined in pounds per cubic foot while the moisture content was determined as a percentage of dry weight. Samples were obtained using a 3-inch O.D. split tube sampler. Test results are shown at the appropriate depths on the Boring Logs, Plates A4.1 and A4.2.

CONSOLIDATION
Selected representative samples were tested for their consolidation characteristics. Test samples were 2.42 inches in diameter and 1 inch high. Porous stones were placed in contact with the top and bottom of test samples to permit addition and release of pore fluid. Loads were then applied in several increments in a geometric progression, and the resulting deformations recorded at selected time intervals. Test results are plotted on the Consolidation Test Reports, Plates B2.1 through B2.3.

SHEAR TEST
Shear tests were performed in the Direct Shear Machine which is of the strain control type. Each sample was sheared under varying confining loads in order to determine the Coulomb shear strength parameters, cohesion and angle of internal friction. Test results are presented on Plates B3.1 and B3.2.
SWELL TEST

Swell tests were performed on representative and air-dried soil samples by placing a 90 psf surcharge load on one-inch high specimens. The samples were inundated with water, and total expansion recorded after a period of at least 24 hours. An air-dried sample was allowed to dry overnight prior to testing. Test results were recorded as a percentage of original height and are summarized in the following table:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Sample Type</th>
<th>Recorded Expansion</th>
<th>Moisture Content Prior to Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 @ 1'</td>
<td>Representative</td>
<td>0.2%</td>
<td>50%</td>
</tr>
<tr>
<td>B1 @ 1'</td>
<td>Air-dried</td>
<td>2.6%</td>
<td>34%</td>
</tr>
</tbody>
</table>

PROCTOR TEST

A Modified Proctor test was performed in general accordance with ASTM D 1557 on a bulk sample obtained from near boring B1 at a depth of about 1.5 feet below grade. The test is used to determine the optimum moisture content at which the soil compacts to 100 percent density. Results are shown on Plate B4.1.

EXPANSION INDEX TESTS

An expansion index test was performed in general accordance with ASTM D 4829. A surcharge load of 144 psf was placed on a one-inch high by four-inch diameter specimen which was molded to about 50 percent saturation. The sample was inundated with water, and total expansion recorded after volumetric equilibrium was reached. An expansion index test performed on a bulk soil sample, obtained from near boring B1 at a depth of about 1.5 feet, resulted in an expansion index of 39, corresponding to a low expansion potential.
Consolidation Test Results

Sample Description
Boring No.: B1 Depth (ft): 5
Soil Description: Brown clayey silt

<table>
<thead>
<tr>
<th>Moisture Content (%)</th>
<th>Dry Density (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial 49.4</td>
<td>65.5</td>
</tr>
<tr>
<td>Final    47.1</td>
<td>68.4</td>
</tr>
</tbody>
</table>

Remark: 2/2/12

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Hirata & Associates, Inc. CONSOLIDATION TEST

Plate B2.1
Consolidation Test Results

Sample Description
Boring No.: B2  Depth (ft): 4
Soil Description: Brown clayey silt with coral and basalt gravel

<table>
<thead>
<tr>
<th>Moisture Content (%)</th>
<th>Dry Density (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial: 45.3</td>
<td>67.1</td>
</tr>
<tr>
<td>Final: 43.3</td>
<td>68.8</td>
</tr>
</tbody>
</table>

Remark: 2/13/12

W.O. 12-5272
Hirata & Associates, Inc.

Vet Tech Facility - Windward Community College

CONSOLIDATION TEST
Consolidation Test Results

Sample Description
Boring No.: B2  Depth (ft): 8
Soil Description: Brown clayey silt

<table>
<thead>
<tr>
<th>Moisture Content (%)</th>
<th>Dry Density (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>57.8</td>
</tr>
<tr>
<td>Final</td>
<td>54.0</td>
</tr>
</tbody>
</table>

Remark: 2/2/12

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Hirata & Associates, Inc.

CONSOLIDATION TEST

Plate B2.3
Direct Shear Test Results

Sample Description

Boring No.: B1
Depth (ft): 3
Soil Description: Brown clayey silt
Strength Intercept (C): 1070.4 PSF
Friction Angle ($\phi$): 28.5 DEG

Remark: 2/17/2012
W.O. 12-5272
Vet Tech Facility - Windward Community College
Hirata & Associates, Inc.

DIRECT SHEAR TEST
Plate B3.1
Direct Shear Test Results

Sample Description

Boring No.: B2  
Depth (ft): 4  
Soil Description: Brown clayey silt with coral and basalt gravel  
Strength Intercept (C): 925.7 PSF  
Friction Angle (φ): 15.2 DEG

Remark: 2/17/2012

W.O. 12-5272  
Vet Tech Facility - Windward Community College

Hirata & Associates, Inc.  
DIRECT SHEAR TEST

Plate B3.2
Soil Data
Location: Near boring B1 at 1.5 feet
Description: Brown clayey silt

Test Results
Maximum Dry Density: 101.5 pcf
Optimum Moisture Content: 26%
February 8, 2012

Ms. Jen Toba-Davila, DArch, LEED AP
Shimokawa+Nakamura
1580 Makaloa Street, Suite 1050
Honolulu, HI 96814

UNIVERSITY OF HAWAII
WINDWARD COMMUNITY COLLEGE
HALE IMILOA, VETTECH FACILITY
LEAD PAINT TESTING
UH PROJECT NO.: SW-12-6238

Dear Ms. Toba-Davila,

Kimura International, Inc. (KI) is pleased to submit this letter report documenting the hazardous materials survey conducted on January 20, 2012, at Hale Imiloa on the campus of the Windward Community College in Kaneohe, Hawaii.

Scope of Work

As requested by Shimokawa+Nakamura, KI conducted the following activities at the project site:

- Collected a composite samples of paint from the exterior structures on the outside of Hale Imiloa that will be affected by the project. These samples were collected in accordance with United States Environmental Protection Agency (EPA) guidelines and analyzed by flame atomic absorption spectroscopy to determine lead content;

- Performed a visual survey of the existing transformer for leaks. No leaks were identified.

- Provided this letter report documenting the results of KI's survey and site observations.
FIELD WORK

On January 20, 2012, KI collected a total of 3 paint samples for lead content on the exterior walls, pipes and transformer shell located on the west corner of Hale Imiloa. All samples were properly logged and recorded following strict chain of custody procedure and submitted to EMC Labs, Inc. (EMC) in Phoenix, Arizona for lead analysis via EPA SW-846, Method 7420. EMC is accredited for lead-based paint analysis through successful participation in the National Lead Laboratory Accreditation Program (NLLAP).

In addition, concern was raised by the client that the transformer present in the project location may have leaked PCB containing transformer oil. A visual survey of the transformer found it to be in relatively good condition, with no significant holes in its outer shell. No staining of the concrete pad or surrounding asphalt was evident, and no unusual odors were detected at the time of the inspection.

RESULTS

Lead-Based Paint

EPA defines lead-based paint as any material containing greater than or equal to 0.5% lead by weight or 5,000 milligrams/kilogram. EPA considers such paint in deteriorated condition as a hazard. Based on this lead-based paint sampling and analytical laboratory report, none of the paint samples are considered to be lead-based paint.

However, the United States Occupational Safety and Health Administration (OSHA) and State of Hawaii Occupational Safety and Health (HIOSH) define paint or other coatings containing any amount of lead as lead-containing paint. When lead-containing paint is encountered during renovation or demolition, OSHA and HIOSH requirements apply, and any work should be performed in compliance with 29 CFR 1926.62 and HIOSH 12-148.1. The paint samples for which accredited laboratory analysis (flame atomic absorption spectrometry) identifies the presence of lead at or above the analytical limit of detection are considered lead-containing paint. If the lead is not detected at or above the analytical limit of detection, the paint sample may be considered non-lead containing paint. The white paint on the exterior pipes was found to contain 0.014% lead. As such, OSHA and HIOSH regulations would apply when working on the railings. A summary of the lead paint samples are provided in Table 1.

Table 2. Summary of lead-containing paint samples.

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Sample Location</th>
<th>Sample Description</th>
<th>Reporting Limit (% by weight)</th>
<th>Lead (% by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120-L01</td>
<td>Exterior walls</td>
<td>white textured paint</td>
<td>0.010</td>
<td>BRL</td>
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<tr>
<td><strong>120-L02</strong></td>
<td><strong>Exterior pipes</strong></td>
<td><strong>white paint</strong></td>
<td><strong>0.010</strong></td>
<td><strong>0.014</strong></td>
</tr>
<tr>
<td>120-L03</td>
<td>Transformer</td>
<td>green paint</td>
<td>0.010</td>
<td>BRL</td>
</tr>
</tbody>
</table>

BRL = Below Reportable Limits

**Bold italics represent lead-containing paint samples**
**PHOTOGRAPHIC DOCUMENTATION**

**Figure 1.** A view of the external pipes emerging from the west wall of Hale Imiloa. The paint on the pipes was found to contain lead.

**Figure 2.** The green paint on the shell of the transformer was sampled for lead. No lead was detected. The transformer was found in relatively good condition, and no visible staining of the surrounding areas was observed.
**DISCUSSION**

Lead-containing paint was discovered on the exterior pipes in the project area. Care should be taken to prevent contamination of surrounding surfaces during work activities. Environmental specifications should be drawn up prior to work onsite. These specifications will address proper work techniques in dealing with lead-containing paint and will also address handling and disposal of lead-containing paint contaminated items.

A visual survey of the transformer revealed no suspected leaks of transformer fluid. The transformer carton appeared to be in relatively good condition, with no significant holes. No staining was evident on the concrete pad or surround asphalt. As a result, KI believes that soil sampling for PCBs in the area is not warranted at this time.

However, a "NO PCB" label was not found on the carton. It is therefore possible that the oil within the transformer does contain PCBs. KI recommends that the services of a hazardous materials company trained in the handling and disposal of transformers and possible PCB containing transformer oil be retained to sample the fluid. If the oil is found to contain PCBs, it is recommended that environmental specifications be produced that address its proper handling and disposal.

**CERTIFICATIONS AND LIMITATIONS**

Kimura International’s findings are based on research, site observations, government regulations, and laboratory data, which were gathered at the time and location of the study. We make no guarantee or warranty, either expressed or implied, except that our services are consistent with good commercial or customary practices designed to conform with acceptable industry standards.

If there are any questions regarding this report, please do not hesitate to contact us at (808) 944-8848.

Thank you for the opportunity to provide Shimokawa+Nakamura with our environmental consultation services.

Sincerely,

**KIMURA INTERNATIONAL, INC.**

[Signature]

Fletcher Kimura, Ph.D.
Environmental Scientist

Enclosures: Laboratory Results
# LEAD (Pb) IN PAINT CHIP SAMPLES

**EMC SOP METHOD #L01/1**  
**EPA SW-846 METHOD 7420**

<table>
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<td>CLIENT:</td>
<td>Kimura International Inc.</td>
<td>REPORT DATE:</td>
<td>01/27/12</td>
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<tr>
<td>CLIENT ADDRESS:</td>
<td>1600 Kapiolani Blvd, #1600 Honolulu, HI 96814</td>
<td>DATE OF ANALYSIS:</td>
<td>01/27/12</td>
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<td>PROJECT NAME:</td>
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<td>P.O. NO.:</td>
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<td>PROJECT NO.:</td>
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<th>SAMPLE DATE /12</th>
<th>CLIENT SAMPLE #</th>
<th>DESCRIPTION</th>
<th>REPORTING LIMIT (%Pb by weight)</th>
<th>%Pb BY WEIGHT</th>
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<td>0.014</td>
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<td>01/20</td>
<td>120-L03</td>
<td>Transformer / Paint Green</td>
<td>0.010 BRL</td>
<td></td>
</tr>
</tbody>
</table>

^ = Dilution Factor Changed  
* = Excessive Substrate May Bias Sample Results  
BRL = Below Reportable Limits  
# = Very Small Amount Of Sample Submitted, May Affect Result

This report applies to the standards or procedures identified and to the samples tested only. The test results are not necessarily indicative or representative of the qualities of the lot from which the sample was taken or of apparently identical or similar products, nor do they represent an ongoing quality assurance program unless so noted. Unless otherwise noted, all quality control analyses for the samples noted above were within acceptable limits.

Where it is noted that a sample with excessive substrate was submitted for laboratory analysis, such analysis may be biased. The lead content of such sample may, in actuality, be greater than reported. EMC makes no warranty, express or implied, as to the accuracy of the analysis of samples noted to have been submitted with excessive substrate. Resampling is recommended in such situations to verify original laboratory results.

These reports are for the exclusive use of the addressed client and are rendered upon the condition that they will not be reproduced wholly or in part for advertising or other purposes over our signature or in connection with our name without special written permission. Samples not destroyed in testing are retained a maximum of sixty (60) days.
**CHAIN OF CUSTODY**
EMC Labs, Inc.
9830 S. 51ST St., Ste B-109
Phoenix, AZ 85044
(800) 362-3373  Fax (480) 893-1726

**LAB#:** 44384
**TAT:** 1-2 Day
**Rec’d:** 1/26/97

**COMPANY NAME:** KIMURA INTERNATIONAL INC.
1600 Kapiolani Blvd, #1600
Honolulu, HI 96814

**CONTACT:** Brandis Ueyama  SCAN COC
Phone/Fax: (808) 944-8848 / (808) 941-8999
Email: bueyama@kimurainternational.com

Now Accepting: **VISA – MASTERCARD**  Price Quoted: $_____ / Sample $_____ / Layers

**COMPLETE ITEMS 1-4:** (Failure to complete any items may cause a delay in processing or analyzing your samples)

1. **TURNAROUND TIME:** [4hr rush] [8hr rush] [1-Day] [2-Day] [3-Day] [5-Day] [6-10 Day]

2. **TYPE OF ANALYSIS:** [Bulk-PLM] [Air-PCM] [Lead] [Point Count] [Fungi: AOC, W-C, Bulk, Swab, Tape]

3. **DISPOSAL INSTRUCTIONS:** [Dispose of samples at EMC] / [Return samples to me at my expense]
(If you do not indicate preference, EMC will dispose of samples 60 days from analysis.)

4. **Project Name:** WCC Vet Facility

<table>
<thead>
<tr>
<th>EMC SAMPLE #</th>
<th>CLIENT SAMPLE #</th>
<th>DATE &amp; TIME SAMPLED</th>
<th>LOCATION/MATERIAL TYPE</th>
<th>Samples Accepted Yes / No</th>
<th>AIR SAMPLE INFO / COMMENTS</th>
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**SPECIAL INSTRUCTIONS:**
Sample Collector: (Print) ___________________________ (Signature) ___________________________

Relinquished by: ___________________________ Date/Time: 1/26/97 Received by: [Signature] Date/Time: 1/26/97

Relinquished by: ___________________________ Date/Time: 1/26/97 Received by: [Signature] Date/Time: 1/26/97

**In the event of any dispute between the above parties for these services or otherwise, parties agree that jurisdiction and venue will be in Phoenix, Arizona and prevailing party will be entitled to attorney’s fees and court costs.**

Rev. 09/01/08
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<td>120-L02</td>
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<td>transformer</td>
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</tr>
</tbody>
</table>

Sampled By: Fletcher Kimura
Relinquished By: [signature]
Received By: [signature]

Additional Attached Field Notes Sheet (yes / no)
Date/Time: 1/20/2012, 13:00-13:20
Date/Time: 1/25/12, 12:00 pm
Date/Time: 1/26/12, 9:30