CONTRACT DOCUMENTS
AND
SPECIFICATIONS
FOR
HAIKEY CREEK OPERATION & MAINTENANCE
CAPITAL EQUIPMENT REPLACEMENTS
RMUA PROJECT NO. WPC 20-2
BAMA PROJECT NO. 205433

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

PREPARED BY:
HOLLOWAY, UPDIKE AND BELLEN, INC.
905-A SOUTH 9TH STREET
BROKEN ARROW, OK 74012
918-251-0717 OFFICE
918-251-0754 FAX

CLAYTON EDWARDS, P.E.
DIRECTOR
WATER AND SEWER DEPARTMENT

CHARLES VOKES
UTILITIES DIRECTOR

Account Number: 9508900-541101
9518900-541101

Water and Sewer Department
175 E. 2nd Street, Suite 1400
Tulsa, Oklahoma 74103
(918) 596-9845

TECHNICAL SPECIFICATIONS
PROJECT SPECIFICATIONS
FOR
REGIONAL METROPOLITAN UTILITY AUTHORITY
PROJECT NO. WPC 20-2
BROKEN ARROW MUNICIPAL AUTHORITY PROJECT ID. 205433
HAIKEY CREEK OPERATION & MAINTENANCE
CAPITAL EQUIPMENT REPLACEMENTS
TULSA, OKLAHOMA

TABLE OF CONTENTS

SECTION                                PAGES
200 INTRODUCTION                     1
201 QUALIFICATION REQUIREMENTS           1
202 SUMMARY OF BID ITEMS             3
203 DESCRIPTION OF BID ITEMS/WORK    1-3
  203.100 Roof System Replacement       3
  203.400 Doors                        2
  203.600 HVAC Controls                145
  203.998 Mobilization Bid Item         1
  203.999 Unforeseen Mechanical, Electrical, Plumbing 1
204 ANCILLARY EQUIPMENT & WORK        1-8
  204.4 General Electrical            8
  204.5 Painting                      3
  204.6 Concrete Coating              2
  204.7 Concrete Rehabilitation       7
  204.8 Cast-In-Place Concrete         17
205 SUBMITTALS                        1-6
206 MONTHLY PROGRESS REPORTS AND PROGRESS MEETINGS 7
207 SECURITY                          7-9
208 SAFETY                            9-10
209 PROTECTION OF PROPERTY            10-11
210 PROTECTION OF MATERIALS           11
211 REFERENCES TO OTHER SPECIFICATIONS 11
212 CLEAN-UP                          11
213 PLACING WORK IN SERVICE           11
214 PAYMENT                           12
INTRODUCTION

200.1 Project work shall include all equipment, labor, materials, and incidentals necessary to remove existing equipment that is to be replaced, install the new equipment, and place the new equipment in fully operational, functional and warrantable service. All equipment to be supplied shall be brand new current year model and not used, remanufactured, or discontinued items.

200.2 The Authority’s contact people are:

<table>
<thead>
<tr>
<th>Water Pollution Control:</th>
<th>Matt Vaughan, Section Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>175 E. 2nd Street, Suite 1400</td>
</tr>
<tr>
<td></td>
<td>Tulsa, OK 74103</td>
</tr>
<tr>
<td></td>
<td>918-596-9845</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:mvaughan@cityoftulsa.org">mvaughan@cityoftulsa.org</a></td>
</tr>
<tr>
<td>Haikey Creek Wastewater Plant</td>
<td>Andy Lankford, Haikey Creek WWTP Superintendent</td>
</tr>
<tr>
<td></td>
<td>11602 E 151st Street</td>
</tr>
<tr>
<td></td>
<td>Broken Arrow, OK 74011</td>
</tr>
<tr>
<td></td>
<td>918-369-5961</td>
</tr>
<tr>
<td>Support Services</td>
<td>Cindy Cantero, Manager</td>
</tr>
<tr>
<td></td>
<td>175 E. 2nd Street, Suite 1400</td>
</tr>
<tr>
<td></td>
<td>Tulsa, OK 74103</td>
</tr>
<tr>
<td></td>
<td>918-596-9870</td>
</tr>
</tbody>
</table>

201 QUALIFICATION REQUIREMENTS

201.1 Only contractors holding a valid pre-qualification certificate from the Tulsa Metropolitan Utility Authority in Classification A or D, General Utility Constructions, are eligible to bid on this project. No additional qualification information is required to be submitted.

201.2 Only contractors that attend the mandatory pre-bid meeting will be allowed to bid on this project.

201.3 SUMMARY OF BID ITEMS

The Basis of Award shall be ten (10) bid items 1 through 5 and Additive Alternates 1-5. The lowest responsible bid shall be determined by the Base Bid amount for Bid Items 1 through 5 plus the Additive Alternate Bid Items 1-5.
<table>
<thead>
<tr>
<th>BID ITEM</th>
<th>SPEC NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>203.100</td>
<td>All materials, labor, equipment, and supervision required for the RDT Building Roof and Hand-railing at Haikey Creek WWTP per these specifications.</td>
</tr>
<tr>
<td>2</td>
<td>203.200</td>
<td>All materials, labor, equipment, and supervision required for the RAS Pump Jib Crane at Haikey Creek WWTP per these specifications.</td>
</tr>
<tr>
<td>3</td>
<td>203.500</td>
<td>All materials, labor, equipment, and supervision required for the Force Main Repairs at Haikey Creek WWTP per these specifications.</td>
</tr>
<tr>
<td>4</td>
<td>203.600</td>
<td>All materials, labor, equipment, and supervision required for the Operation building HVAC Controls Improvements at Haikey Creek WWTP per these specifications.</td>
</tr>
<tr>
<td>5</td>
<td>203.999</td>
<td>Mechanical, Electrical, Plumbing and Unforeseen Circumstances Allowance for various mechanical, electrical, plumbing and unforeseen work not shown on the construction drawings or specified in the contract documents.</td>
</tr>
</tbody>
</table>

Additive Alternate No. 1

| 6        | 203.300  | All materials, labor, equipment, and supervision required for the RDT Building Hot Water Tank at Haikey Creek WWTP per these specifications. |

Additive Alternate No. 2

| 7        | 203.400  | All materials, labor, equipment, and supervision required for the Six Passage Doors Improvements at the RDT Building at Haikey Creek WWTP per these specifications. |

Additive Alternate No. 3

| 8        | 203.700  | All materials, labor, equipment, and supervision required for the RDT Building & HVAC System Improvements at Haikey Creek WWTP per these specifications. |

Additive Alternate No. 4

| 9        | 203.800  | All materials, labor, equipment, and supervision required for the Operations Building Garage and Pump room Ventilation System Improvements at Haikey Creek WWTP per these specifications. |

Additive Alternate No. 5

| 10       | 203.900  | All materials, labor, equipment, and supervision required for the Lighting Upgrades at Haikey Creek WWTP per these specifications. |

END OF SECTION
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>INTRODUCTION</td>
</tr>
<tr>
<td>201</td>
<td>QUALIFICATION REQUIREMENTS</td>
</tr>
<tr>
<td>202</td>
<td>SUMMARY OF BID ITEMS</td>
</tr>
<tr>
<td>203</td>
<td>DESCRIPTION OF BID ITEMS/WORK</td>
</tr>
<tr>
<td>203.100</td>
<td>HCWWTP Roof System Replacement</td>
</tr>
<tr>
<td>203.400</td>
<td>HCWWTP Doors</td>
</tr>
<tr>
<td>203.998</td>
<td>Mobilization Bid Item</td>
</tr>
<tr>
<td>203.999</td>
<td>Unforeseen Mechanical, Electrical, Plumbing Allowance</td>
</tr>
<tr>
<td>204</td>
<td>ANCILLARY EQUIPMENT &amp; WORK</td>
</tr>
<tr>
<td>204.4</td>
<td>General Electrical</td>
</tr>
<tr>
<td>204.5</td>
<td>Painting</td>
</tr>
<tr>
<td>204.6</td>
<td>Concrete Coating</td>
</tr>
<tr>
<td>204.7</td>
<td>Concrete Rehabilitation</td>
</tr>
<tr>
<td>204.8</td>
<td>Cast In Place Concrete</td>
</tr>
<tr>
<td>205</td>
<td>SUBMITTALS</td>
</tr>
<tr>
<td>206</td>
<td>MONTHLY PROGRESS REPORTS &amp; PROGRESS MEETINGS</td>
</tr>
<tr>
<td>207</td>
<td>SECURITY</td>
</tr>
<tr>
<td>208</td>
<td>SAFETY</td>
</tr>
<tr>
<td>209</td>
<td>PROTECTION OF PROPERTY</td>
</tr>
<tr>
<td>210</td>
<td>PROTECTION OF MATERIALS</td>
</tr>
<tr>
<td>211</td>
<td>REFERENCES TO OTHER SPECIFICATIONS</td>
</tr>
<tr>
<td>212</td>
<td>CLEAN-UP</td>
</tr>
<tr>
<td>213</td>
<td>PLACING WORK IN SERVICE</td>
</tr>
<tr>
<td>214</td>
<td>PAYMENT</td>
</tr>
<tr>
<td></td>
<td>END OF SPECIFICATIONS</td>
</tr>
</tbody>
</table>

(remainder of page left intentionally blank)
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>203.600 - 15010</td>
<td>Mechanical General</td>
</tr>
<tr>
<td>203.600 - 15015</td>
<td>Firestopping and Smoke Stopping</td>
</tr>
<tr>
<td>203.600 - 15020</td>
<td>Mechanical Demolition</td>
</tr>
<tr>
<td>203.600 - 15030</td>
<td>Electrical Requirements for Mechanical Equipment</td>
</tr>
<tr>
<td>203.600 - 15060</td>
<td>Basic Piping</td>
</tr>
<tr>
<td>203.600 - 15075</td>
<td>Mechanical Identification</td>
</tr>
<tr>
<td>203.600 - 15086</td>
<td>Piping Insulation</td>
</tr>
<tr>
<td>203.600 - 15090</td>
<td>Supports, Hangers and Anchors</td>
</tr>
<tr>
<td>203.600 - 15160</td>
<td>Mechanical System Insulation</td>
</tr>
<tr>
<td>203.600 - 15184</td>
<td>Refrigerant Piping</td>
</tr>
<tr>
<td>203.600 - 15610</td>
<td>VRV Indoor Units</td>
</tr>
<tr>
<td>203.600 - 15620</td>
<td>460V Heat Recovery</td>
</tr>
<tr>
<td>203.600 - 15630</td>
<td>VRV System Controller</td>
</tr>
<tr>
<td>203.600 - 15635</td>
<td>VRV Remote Controller</td>
</tr>
<tr>
<td>203.600 - 15710</td>
<td>HVAC Sheet Metal</td>
</tr>
<tr>
<td>203.600 - 15853</td>
<td>Louvers</td>
</tr>
<tr>
<td>203.600 - 15990</td>
<td>Testing, Adjusting and Balancing</td>
</tr>
</tbody>
</table>

(Brace Brown, P.E.  
OK 20995  
Brown Engineers of Arkansas, LLC  
C.A. No. 4933  
Expires June 30, 2020)
203.100 All materials, labor, equipment, and supervision required for installation of new roofing systems at the HCWWTP RDT building per these specifications. The work and costs includes, but is not limited to new roofing membrane, build up rigid insulation, fascia, custom flashing to equipment/roof mounted items, vent flashing, coping, coordination with roof drains and new walk pads throughout. Other inclusions are protecting, coordinating with existing equipment and items normal to roofing work at commercial facilities and WWTP. **BID COSTS ALSO INCLUDE SPECIAL 15 YEAR WARRANTY WITH CERTIFICATE TO RMUA.** See Bid Proposal for base bid and alternate bid items.

203.100.1 The work consists of the following scope of improvements:

A. Demolition of the existing roofing systems complete, including but not limited to the roof system, ballast as applicable, insulation, flashing, trim, roof penetration flashing, fasteners, fascia or other component of the existing roofing systems for a complete replacement to new roofing system and warrantee.

B. Contractor shall provide new roofing system complete, including but not limited to the roof membrane, insulation, flashing, trim, roof penetration flashing, fasteners, fascia or other component of the roofing system for a complete replacement to new materials and warrantee.

C. Protection of existing roof decking, surface mounted equipment, skylights, vents and another roof mounted item.

D. Refer to Specification Section 204 for additional painting and preparation requirements.

203.100.2 Refer to Contract Drawings for additional information and details.

203.100.3 Project work shall include all materials, equipment, labor, and supervision necessary to complete the project as specified herein, including but not limited to any and all crane work, rigging, scaffolding, access to, work area safety and other items as required to provide a complete and functional installation.

203.100.4 Contractor shall submit work plan acceptable to the Engineer describing the duration and sequence of work. Plan shall be approved prior to commencement of work. Contractor shall coordinate this work with other work in order to minimize time equipment is out of service.
203.100.5 The Contractor shall install equipment and materials in a workmanlike manner utilizing craftsmen skilled in the particular trade. Installation practices shall conform to Manufacturer's recommendations.

203.100.6 Submit all materials for approval prior to work.

203.100.7 **Manufacture Product Warrantees:** Contractor shall coordinate, complete manufacture form requirements and provide the RMUA all final warrantee documentation. Payment for completed in place work shall be 90% of bid item cost and remaining 10% of bid item payment shall represent acceptable completed warrantee paperwork transmitted to the RMUA, c/o Plant Superintendent.

203.100.8 **Contractor shall coordinate and provide a Manufacture’s warrantee commencing on date of substantial completion, including costs for labor and materials for loss of water tightness without financial limit for a period of 15 years with a no dollar limit (NDL).**

203.100.9 Roofing TPO membrane roofing system or PVC membrane roof system shall be manufactured by Carlisle Syntec, Sure Flex PVC membrane roofing with mechanically fastened roofing system and new built up insulation, or approved equal. See contract drawings for requirements and details which govern over specification. All other accessories required for proper operation that meet the following specification:

- **Roof area(s):** See plan sheets.
- **Insulation** Carlisle HP-H Polyiso grade 3 or equal.
- **Walk mats** From each ladder access to and around equipment and items which require maintenance. Additional locations and paths are show on the contract plans.
- **Color of membrane** Standard color, white
- **Electrical improvements:** No new electrical, Provide new welded custom 316 stainless flashing. Custom welded corners. Any laps shall be 6” min and caulked with NP or equal.
- **Skylight(s):** No new skylights, Provide new welded custom 316 stainless flashing. Custom welded corners. Any laps shall be 6” min and caulked with NP or equal.
- Roof Mounted Mechanical: No new equipment. Provide new welded custom 316 stainless flashing. Custom welded corners. Any laps shall be 6” min and caulked with NP or equal.

- Plumbing Vents: Yes, Provide new neoprene rubber stainless flashing at all existing and new piping vent locations.

- Hardware/fastener All new hardware/fasteners shall be 316 Stainless unless specifically specified otherwise. All fasteners exposed shall be caulked.

- Coping, Fascia edge system OMG extruded aluminum cleat TerminEdge Fascia and coping system or equal. Coordinate blocking with insulation and system requirements. Color shall be “Bronze” anodized heavy aluminum flashing.

- Exposed Parapet/Coping New unless shown on the plans otherwise. Work shown on contract plans. Reuse existing.

- Adhesives, primers, bonding Per Roofing System Membrane Manufacture requirements for this project application.

- Step treads (anti-slip steps) Step treads shall be provided to and from any and all ladders to any and all equipment. Step treads shall be laid out around all equipment for maintenance and any roof item requiring regular or periodic maintenance. Contractor to confirm existing equipment and general layout for submittal sketch for approval of the step tread paths as part of the material submittal package.

- Roof Drains See plan sheets.

- Lightning Protection Reconnect lightning protection with new fasteners as required. Protect existing system during construction. Replace
cable hold down clips and glue to new roofing system. Maintain system design and coordinate cables with existing routing and layout.

203.100.10 TAGGING: No tagging is required.

END OF SECTION
203.400 All materials, labor, equipment, and supervision required for installation of a new doors at the Haikey Creek WWTP RDT Building, per these specifications.

203.400.1 The work located at the RDT Building located at the Regional Metropolitan Utility Authority Haikey Wastewater Plant, consists of the following scope of improvements:

A. Installation of new exterior grade commercial doors.

B. Installation of new louvers integral to all doors and door frames being replaced. Coordinate louvers with existing fans or ductwork as required.

C. Rehabilitate and repair one door frame and door (see plan sheet door schedule for location).

D. Coordination with existing equipment and/or installation of new equipment with Plant operations.

E. Other work and details are shown on the plan sheets

203.400.2 Refer to Contract Drawings for additional information and details.

203.400.3 Project work shall include all materials, equipment, labor, and supervision necessary to complete the project as specified herein, including but not limited to any and all crane work, rigging, scaffolding and other items as required to provide a complete and functional installation.

203.400.4 Contractor shall submit work plan acceptable to the Engineer describing the duration and sequence of work. Plan shall be approved prior to commencement of work. Contractor shall coordinate this work with other work in order to minimize time equipment is out of service.

203.400.5 Submit materials for approval prior to work.

203.400.6 Doors and parts shall be manufactured by Pioneer, DLS, or approved equal. All other accessories required for proper operation that meet the following specification:

-Number of double doors: See plan sheet door schedule.

-Door model: Exterior Industrial heavy duty. Some with upper half having safety glass window (See plan sheet door schedule)

-Hardware 316 Stainless hardware, hinges, push bar and lockset (stainless finish is not
acceptable). Locks shall match plant key system. Existing lock sets are Medeco locks.

Automatic closures

Double doors shall have locking mechanism to head & sill

-Door Swing: See door schedule and include in submittal(s)

-Material construction: Heavy duty industrial slab doors, 14 gauge construction. Factory finished in color “dark bronze”. Final color approved by Owners Representative.

203.400.7 **TAGGING:** Building name tag is required at all doors on UV stable Formica signage with 1.5” letters and applied onto buildings doors with adhesive caulk. See tagging specification for additional information. Coordinate final locations and placement with Owners Representative.

END OF SECTION
PART 1  GENERAL

1.1.  CONTRACT DOCUMENTS

A. Drawings are diagrammatic, due to scale, and indicate the general arrangements and geometric relationships of equipment, systems, and services. They are not intended to show or indicate every offset, sequence, device, option, fitting, valve, or accessory. Plan work around building details and other crafts. Do not scale drawings for exact sizes and locations.

B. Contractor shall base all his measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Contractor shall verify all measurements at site and check correctness as related to the work.

C. In case of interferences between trades, Engineer will decide which work is to take precedence regardless of work that might be installed.

1.2.  CODES, ORDINANCES, INSPECTIONS AND PERMITS

A. Work is to be executed and inspected in accordance with local and State codes, laws, ordinances, rules and regulations applicable to particular class of work, including the State Mechanical Code, State Plumbing Code, State Gas Code, and State Fire Code. Associated fees shall be paid by the Contractor.

B. Should any part of drawings or specifications be found to be in conflict with applicable codes or ordinances, notify the Engineer, in writing, within 72 hours prior to bid deadline for review and/or correction of bid documents. After project bidding is closed, any discovery of code violations shall be promptly reported to the Engineer. Any work performed in violation of applicable codes or ordinances shall be corrected without additional expense to the Owner or his representatives.

C. Pressure and heating vessels, including hot water storage containers, shall be constructed in compliance with the rules and regulations of the Boiler Inspection Division of the State. All installations of such equipment shall be made by a firm licensed and approved by the Boiler Inspection Division of the State.

D. Facilities shall be installed in compliance with the requirements of the current version of the Americans with Disabilities Act (ADA). Installation of mechanical and plumbing systems including fixtures and control mounting heights, clear knee space, and access clearances shall comply with ADA required dimensions, and as shown on details or schedules when shown.

E. Contractor shall arrange with County, City or State, if City has no ordinances covering work, for complete inspection, paying all charges required. Give proper authority requisite notice relating the work; afford Engineer and authorized inspectors adequate access to the Work for inspection; and be responsible for all violations of law. Upon completion of work, have work inspected, if required, obtaining certificates of inspection and approval from inspecting agency and deliver certificates to Engineer and Owner.

1.3.  REVIEW OF CONTRACT DOCUMENTS AND SITE

A. With the submission of his bid, Contractor shall give written notice to the Engineer of any
materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that the Contractor has included the cost of all required items in his proposal for a complete project.

B. Contractor shall acknowledge that he has examined the Plans, Specifications, and Site, and that from his own investigation he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage or materials; availability of labor, water, electric power, roads and uncertainties of weather; the confirmation and condition of the ground; the characters, quality and quantity of subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the Work, especially the prohibited use of Owner's permanent equipment, ductwork, and controls; all federal, state, county, township and municipal laws, ordinances, and regulations particularly those relating to employment of labor, wage rates, and construction methods; and all other matters which can in any way affect the Work or the associated cost of the Work under this Contract. Any failure by the Contractor to acquaint himself with the available information concerning these conditions will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work.

C. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.

1.4. USE OF THE OWNER'S EXISTING AND NEW, PERMANENT HVAC SYSTEM DURING CONSTRUCTION

A. Use of the Owner’s existing and currently being installed, permanent HVAC system during Construction is prohibited. Provide temporary means for heating and cooling required by construction activities for curing or drying completed installations or for protecting installed construction from adverse effects of temperature and humidity. Provide temporary dehumidification systems when required to reduce substrate moisture levels required to accommodate installation or application of finishes.

B. Maintain a minimum ambient temperature of 50 DEG. F. in areas where construction is in progress, unless indicated otherwise in the specifications.

C. Prevent dust, fumes, construction debris, and odors from entering existing and newly installed HVAC equipment, ductwork, and control system components. Prior to commencing work, isolate HVAC equipment. Where existing HVAC systems will be affected, isolate existing supply, return, and exhaust ducts by disconnecting ductwork at point where existing duct shall remain. Cover ends of existing ductwork securely with black plastic material.

D. Newly installed ductwork shall be thoroughly cleaned before installation. Each section that is installed at the end of the day shall have open ends securely covered with black plastic material.
E. Newly installed HVAC equipment shall be securely covered and protected with black plastic material or by other approved method. After installation of air moving equipment, duct connections shall be securely covered with black plastic material. Connections to duct systems shall not be made until final finishes have been installed, areas served are clean, and building is ready for HVAC equipment start-up and use.

F. Securely cover control system components to prevent damage from construction debris, dust, and dirt. Control systems shall not be energized for testing and adjusting until HVAC system start-up.

G. HVAC Equipment, Ductwork, and Control Components contaminated by construction debris, dirt, and construction dust shall not be acceptable and shall be replaced at no additional cost to the Owner. HVAC Equipment, Ductwork, and Control components shall be kept clean throughout construction. Cleaning after an HVAC system has been contaminated shall not be an acceptable alternate to replacement.

1.5. SHOP DRAWINGS AND SUBMITTALS

A. Submit manufacturer’s catalog sheets and/or shop drawings covering all phases of work included in this Contract.

B. Arrange submittals in sets and bind in 3 ring binders. Loose sheets are not acceptable. Indicate for each item the location, system, or position where it is to be used, arrange by equipment type and tab sections.

1. Individual submittal packages may be made for plumbing, HVAC, fire protection, test and balance, and controls. The Contractor may submit up to 5 different packages, but where practical provide all submittals in a single 3-ring binder.

2. Items which are required to be resubmitted shall come in a single 3-ring binder. Approved equipment is not required to be resubmitted.

3. The Contractor is responsible for verification that all items are submitted.

C. Submittals shall bear written certification to the effect that the Contractor has examined them and found them to include all items required to be submitted and to be in accordance with specifications.

D. Submittals are required even though equipment being furnished is exactly as specified.

E. Submittals shall include all data required in individual sections of these specifications.

F. Contractor is responsible for making all submittals required by the specifications for approval. If equipment is delivered or installed without an approved submittal, Contractor may be required to remove and replace equipment with specified and approved equipment, as directed by the Engineer, without additional cost to the project.

G. Exceptions for Submittals

1. Exceptions to the Specifications or Drawings shall be clearly defined in a separate section of each submittal package. The submittal shall contain the reason for the exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an “or equal” or “exception” to the
Specifications shall be at the sole discretion of the Engineer.

2. By noting the term "compliance", it shall be understood that the Contractor is in full compliance with the item specified and will provide exactly the same with no deviations.

3. By noting the term "deviation", it shall be understood that the Contractor prefers to provide a different component in lieu of the one specified and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the Owner.

4. By noting the term "alternate", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner and in so doing, takes full responsibility for making the equipment work as specified and will provide necessary ancillary components to make the equipment work at no extra cost to the Owner. The alternate method shall be fully described with schematic diagrams and one-line diagrams as applicable.

1.6. SUBSTITUTION OF MATERIALS

A. Final decision as to whether or not a specific piece of equipment meets specifications shall rest with Engineer.

B. Substitution requests will not be accepted prior to bid.

C. Equipment and material manufacturers are referenced in the Plans and Specifications to establish the basis of design and required standards.

D. With each Substitution Request, submit technical data that will fully establish the equality of the proposed substitute product with that listed. Submit completed Substitution Request Form.

E. Substitution Request Submission Process

1. The naming of a manufacturer's product with the words "basis of design" or the naming of a single manufacturer's product on a drawing equipment schedule, on other drawings, or in the specifications, establishes that specific product as the basis for design. In the absence of any other named acceptable manufacturer's product, provide the "basis of design" product. No substitutions will be accepted.

2. Where other manufacturer's names are listed on the drawings or in the specifications as acceptable, in addition to the "basis of design" product, substitution request for these manufacturer's shall be made with submittal after the project has bid in order to verify product acceptability. No other substitution requests will be accepted.

3. Where two or more manufacturer's names are given without a clear "basis of design" product being given, no substitution request is required for these manufacturers. These manufacturers are the only acceptable manufacturers.

4. Where the words "approved equal" or "acceptable equal" are used in addition to a manufacturer's name or a list of manufacturer's names, a substitution request must be made within 15 days after award before manufacturer's products other
than those named may be used.

5. Where the words "or equal" are used in addition to a manufacturer's name on a list of manufacturer's names, substitutions can be made without submitting a substitution request. Submittal for the "or equal" product must contain adequate information to demonstrate product is equal to listed manufacturer's products.

6. It is the responsibility of the Contractor to provide all of the data necessary to establish acceptability of the product.

7. Submittal of substitution request form does not insure that the submittal will be accepted.

8. The submittal for the substitution will be reviewed for conformance with the specifications and equality to the specified products. Full submittals will be required of all equipment. Substitution submittals will be reviewed and shall be rejected if the proposed equipment is found to be different than indicated on the Substitution Request Form, or is found deficient compared to scheduled performance/or specifications.

9. The "Substitution Request Form" follows these specifications. The form must be filled out separately for each product proposed for substitution. The form must be filled out completely and signed by the Contractor.

F. Any proposed substitutions of equipment shall be accompanied by product submittal and shop drawings showing revised equipment layouts, piping diagrams, ductwork drawings and/or wiring diagrams. Where substituted equipment furnished requires use of larger, more, or differently arranged connections, such connections shall be installed to the complete satisfaction of Engineer without additional cost to Owner.

G. The Contractor is responsible for full coordination of all changes required by substituted equipment, including dimensional clearance.

H. The Contractor is responsible for all additional costs of equipment installation, coordination and engineering which results from his substitution. This includes all aspects of the work including architectural, structural, civil, electrical, and mechanical. This also includes costs for the redesign time of Architects and Engineers.

I. Costs associated with dimensional, performance, or other deviations from the "basis of design" equipment, including engineering costs to evaluate such deviations, shall be paid by the Contractor. If a product other than the "basis of design" product is submitted and subsequently rejected during the submittal process, Contractor shall provide the "basis of design" product.

J. Should a substitution be accepted and subsequently proven unsatisfactory for the service intended within the warranty period, the Contractor shall provide the basis of design, or make corrections as directed by Engineer.
PROPOSED SUBSTITUTION REQUEST FORM

Remit to: Brown Engineers LLC
17200 Chenal Pkwy, Suite 300 PMB 324
Little Rock, Arkansas 72223
Telephone: (501) 448-0100

DIVISION/SECTION: ____________________________

SPECIFIED ITEM (if applicable):

<table>
<thead>
<tr>
<th>Description</th>
<th>Section</th>
<th>Paragraph</th>
<th>Subparagraph</th>
</tr>
</thead>
</table>

The undersigned Contractor requests consideration of the following:

PROPOSED SUBSTITUTION: ________________________________________________

Attached data includes product description, specifications, drawings, photographs, performance and test data, available colors/finishes adequate for evaluation of the request; applicable portions of the data are clearly identified, both on the proposed substitution and the originally specified product.

Attached data also includes description of changes to Contract Documents, which proposed substitution would require for its proper installation.

DESCRIPTION OF WORK: ________________________________________________

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

The undersigned Contractor must respond to and complete the following questions in their entirety:

1. Will changes be required to the building design or any components or assemblies in order to properly install the proposed substitution? Yes_____ No_____
   If yes, explain: ______________________________________________________
   ___________________________________________________________________

2. The Contractor understands that changes to the building design, including engineering and drawing costs, caused by requested substitution will be the Contractor's burden? Yes_____ No _____
   If no, explain: _____________________________________________________
   ___________________________________________________________________

3. Is weight greater or smaller than specified item? Yes____ No____ By how much? ____________

PROPOSED SUBSTITUTION REQUEST FORM continued
4. Does the substitution affect the Building's dimensions? Yes_____ No_____  
If yes, explain:__________________________________________________________

5. What effect does the substitution have on other trades? List affected trades and explain:  
_____________________________________________________________________
_____________________________________________________________________

6. Does manufacturer’s warranty of the proposed substitution differ or exceed that from specified? Yes_____ No_____  If yes, explain:__________________________________________________________

7. Will maintenance and service parts be available locally for the substitution? Yes_____ No_____  If no, explain:__________________________________________________________

8. Will the proposed substitution require additional testing, inspection, certification or approvals?  
Yes____  No____  If yes, explain:__________________________________________________________

9. Does the proposed substitution affect (increase, decrease, other) the construction schedule? Explain:  
_____________________________________________________________________
_____________________________________________________________________

10. The cost benefit to the Owner is $_______________________ Deduct

GENERAL CONTRACTOR: The undersigned Contractor hereby guarantees that the above questions have been answered correctly and that all of the above-described work will be installed in accordance with Contract Requirements. The undersigned agrees to pay all Architectural and/or Engineering costs, if required, to review, test and/or revise the Drawings and/or Specifications to accommodate this substitution, and furthermore agrees to pay any and all additional construction costs created by this substitution.

Comments:_________________________________________________________________
_____________________________________________________________________
1.7. GUARANTY-WARRANTY

A. Guarantee shall include capacity and integrated performance of component parts of various systems in strict accord with the intent and purpose of these specifications. Conduct such tests as herein specified or as may be required by the Engineer to demonstrate capacity and performance ability of various systems to maintain specified conditions.

B. Compile and assemble the warranties specified in the mechanical division, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment; date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services.

D. All materials and equipment shall carry a full year's warranty from time Owner accepts building or the date of substantial completion, whichever is earlier, regardless of start-up date of equipment, unless a longer warranty period is specified under other sections. Longer warranty periods for specific items shall be listed in other sections of these specifications.

PART 2 MATERIAL

2.1. MATERIAL AND EQUIPMENT

A. Equipment shall be new, undamaged, and of the same manufacturer except where indicated otherwise.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

D. Protect work and equipment at all times from damage, weather, and entrance of dirt and water. Close pipe and duct openings with caps or plugs during installation.

2.2. ELECTRICAL

A. Contractor shall carefully coordinate voltage and amperage requirements of equipment to be provided. Coordinate with Electrical Contractor prior to equipment order. Any change to electrical systems required by Contractor's substitutions or uncoordinated
equipment needs shall be made without cost to the project.

B. Provide all electrical interlock, control, and other wiring, not covered specifically under the electrical drawings and specifications, for proper operation and control of all equipment specified under this Division of the specifications.

C. Supervise and coordinate all electrical work in connection with mechanical systems.

D. Furnish all motor controllers and contactors, not furnished as part of a motor control center, or by Electrical Division for proper operation of all motors. Submit motor data with submittals.

2.3. ROOF AND FLASHINGS

A. Special care shall be taken on roofs to prevent damage. Promptly repair any damage at no additional expense to the Owner. Comply with bonding requirements of new and existing roofs.

B. Flashings are not covered by this section. Refer to Architectural Division.

2.4. ACCESS PANELS

A. Provide access panels in all floors, walls, and plaster and non-lay-in type ceilings as required or as indicated to service devices in piping requiring access, controls, devices in ductwork requiring access, and other system components requiring access for service or regular maintenance. Closely coordinate requirements for access doors before bidding.

B. Access doors shall be "Milcor" type appropriate for the construction involved.

C. Size and type shall be as required for proper service and/or as may be directed by the Engineer. Minimum size to be 24” x 24”.

2.5. ASBESTOS AND OTHER HAZARDOUS OR TOXIC MATERIALS

A. No Asbestos containing materials shall be used on this project.

B. Contractor is responsible for his own means and methods of safety where Hazardous or Toxic materials are use for the installation of his work. All work shall comply with state and federal regulations.

C. Contractor shall protect the Owner’s facility and employees from conditions generated by his work.

D. In the event that a potentially hazardous material is discovered during the course of the work, Contractor shall stop work immediately, and provide for the safety of his employees and other occupants. He shall make proper notifications as required by his contract and by law.

2.6. CONCRETE

A. Concrete materials and installations indicated on the drawings for curbs, pads, and supports for mechanical equipment shall be provided as part of the contract.

B. Comply with other architectural and structural portions of the specifications for materials and methods.
C. Concrete.
   1. Concrete shall be commercial grade containing Portland cement, aggregates, clean water, and mix ratios suitable for the loads, and site conditions.
   2. Concrete shall be 3,000 psi class indoors and 3,500 psi class outdoors unless noted otherwise.
   3. Comply with ACI standards for cold and hot weather applications.

D. Installation
   1. Use rigid and smooth forms to prevent visible defects and deflections in the work. Use form compound to prevent concrete bonding to the forms.
   2. Provide chamfered corners on the tops of curbs.
   3. Reinforce pads and curbs with steel reinforcing bars minimum size number 3, welded wire fabric, or as indicated on the drawings. Set the reinforcing depth within the concrete for optimum strength for the application.
   4. Provide equipment pads of sizes indicated and at least large enough to extend past the mechanical equipment 6” on all sides. Minimum height 6” unless otherwise noted.
   5. Pour pads integral with the floor slab, isolate from the floor slab, or dowel the pads, as indicated on the drawings.
   6. Grout all voids with high strength grout mixture.
   7. Installation of the pads shall be coordinated so that the concrete has set and the strength is suitable for installation of the equipment.
   8. Set anchor bolts where indicated by either equipment manufacturer or Structural Engineer.

2.7. GAS VENTS
   A. Gas vents shall be Metalbestos or Dura-vent double wall type "B" approved by Underwriters Laboratories. Each system shall be complete with pipe, adjustable fittings, draft hood connectors, storm collars, roof flashing and all other accessories necessary for a finished job. Contractor shall refer to Plumbing Plan for water heater vents.
   B. Provide approved vent-tops equal to Ameri-Vent Cap, Model "C". Units shall be galvanized, complete with bird screen. Single wall vents will not be approved for any installation.
   C. Double wall vents shall have no more than the equivalent of 2 - 90 degree angles. Mechanical Contractor shall be responsible for locating flue penetration thru roof for Roofing Contractor. Failure to properly locate vent pipe will result in relocating at no additional cost to Owner.

PART 3 EXECUTION

3.1. LOCAL SITE CONDITIONS
A. Before bidding, make complete investigation at site in order to be informed as to location of utilities and as to conditions under which work is to be performed. Utility locations shown were obtained from surveys and/or local utility companies and are offered as a general guide only and are not to be assured accurate.

B. Make determination of soil conditions before bidding. These specifications and accompanying drawings in no way imply condition of soil to be encountered.

3.2. EXCAVATION, TRENCHING AND BACKFILLING

A. Excavation, trenching, and backfilling in connection with the mechanical system, to a point 5'-0" outside the building, is included as part of this Division, unless indicated otherwise.

B. Excavation required shall be done as part of the contract price regardless of any implied conditions on the drawings or in these specifications.

C. Excavation to have 12" minimum and 24" maximum clearance on all sides. Do not carry excavation below required level unless indicated otherwise on the drawings. Excess excavation below required level shall be backfilled at no expense to Owner with earth, sand, gravel, or concrete, as directed by Engineer and thoroughly compacted. Remove any unstable soil and replace with gravel, crushed stone, or clean sand and thoroughly compact. Engineer will determine the depth of removal of any unstable soil encountered. Grade ground adjacent to excavation to prevent water from running into excavation. Remove accumulated water in the excavation.

D. Banks of trenches shall be vertical or as shown on the drawings. Width of trench shall be 5" minimum, 8" maximum on each side of pipe bell. Excavate bell holes accurately to size by hand. In rock, excavations shall be carried 8" below bottom of pipe. Use loose earth or gravel for backfill and tamp thoroughly.

E. Bracing, sheathing, and shoring shall be performed as necessary to complete and protect excavations indicated on the drawings, as required for safety, as directed by Engineer, and to conform to governing laws and state and federal regulations. Comply with OSHA Regulations.

F. After piping installation, inspection, testing, and approval by governing agency; backfill trenches with clean, stable soil free from stones. Place backfill in 4" layers, tamped under and around pipe and conduit to height of at least 2' above pipe. Tamping shall be done in such manner as not to disturb underlying work. Remainder of trenches and excavations shall be backfilled with clean, stable earth, deposited in 8" layers and brought up to rough grade, with each layer compacted to density of surrounding soil. Remove sheathing and shoring as backfill is placed and fill space with dry sand. Compaction tests may be required by the Engineer, with the costs paid by the Contractor.

G. Underground piping shall be marked with metallic marking tape inserted in the trench a minimum of 12" below grade and a minimum of 12" above mains.

F. Replace existing appurtenances removed or damaged in connection with work, and restore to original conditions, unless directed otherwise.

3.3. MECHANICAL INSTALLATIONS:
A. Coordinate mechanical equipment and material installation with other building components and other trades. Investigate each space in the structure through which mechanical equipment furnished under these specifications must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

B. Verify all dimensions by field measurements. By ordering equipment, Contractor assumes responsibility for the installation and orientation of equipment in the available space.

C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

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

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

F. Fit equipment, pipe, and duct into the available spaces in the building and introduce into the building, at a time, and in a manner, as not to damage the structure. Install ductwork and piping to provide the maximum possible clear height underneath.

G. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

H. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

I. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.

J. Coordinate the installation of mechanical materials and equipment above ceilings with suspension systems, light fixtures, and other installations.

K. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

L. Do not support material or equipment of other trades from piping or ductwork.

M. Do not use equipment, piping, or ductwork as scaffolding, scaffolding support, or as other means to access the work. Damaged systems and components shall be repaired or replaced in accordance with the full satisfaction of the Owner and Engineer.

N. Core drill piping penetrations of concrete walls, floors, and other concrete structures.

O. Equipment locations shown on the drawings are approximate. Final locations shall be established and determined in the field to best utilize available space.

P. Replace architectural features removed or damaged during the course of the work.

Q. Maintain fire assembly ratings as dictated by authorities having jurisdiction. Seal around penetrations through UL rated assemblies, fire, and smoke walls.

R. Fully seal around duct or pipe routed through exterior walls.
3.4. **EQUIPMENT CONNECTIONS**

A. Each equipment item with drain connections shall be provided with a properly-sized drain run to the nearest floor drain or as directed.

B. Rough-in and make final required connections to equipment, furnished under other Divisions of the Specifications or by the Owner.
   1. Provide necessary labor and materials for a complete installation. Trap and vent drainage connections as required.
   2. If equipment or fixtures furnished by others are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed, ready for future connection.

C. No equipment or fixture shall be "roughed-in" until proper rough-in drawings are provided to the installer.

D. Extend grease fittings to accessible locations.

3.5. **CUTTING AND PATCHING**

A. Provide cutting and patching required to perform the mechanical work, when alteration, repair, renovation, or addition, to existing construction is specified or required for new work.

B. Cutting of structural members will not be permitted except through explicit instructions from the Engineer. Reinforcing will be required where members are cut.

C. Do not endanger or damage installed work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.

E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

F. Perform cutting, fitting, and patching required to:
   1. Uncover Work to provide for installation of ill-timed Work.
   2. Remove and replace defective Work.
   3. Remove and replace Work not confirming to requirements of the Contract Documents.
   4. Remove samples of installed Work as specified for testing.
   5. Upon written instructions from Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.

3.6. **GROUTING**

A. Mix and install grout for mechanical equipment base bearing surfaces, base plates, and anchors.

B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

I. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.

3.7. SEISMIC

A. Mechanical systems shall be installed in conformance with the requirements of the state and federal codes and regulations for Seismic considerations, as specified and noted on the drawings.

B. All seismic restraining and snubbing devices shall be manufactured specifically for this duty. Devices constructed by the Contractor will not be accepted.

C. Contractor shall be responsible for the design and installation of the restraining and snubbing systems based on the criteria included on the drawings and in the specifications, and the actual equipment, and locations of installation.

3.8. START UP, TESTING, AND ADJUSTING

A. Contractor shall include adequate time in construction schedule for HVAC system start-up; testing, adjusting, and balancing; and control system installation, programming, testing, and commissioning.

B. Each and every phase of the plumbing, air conditioning, heating and ventilating systems shall be operated separately, or in conjunction, one with the other, for a sufficient period of time to demonstrate to the entire satisfaction of the Engineer the ability of the systems to meet the capacity and the performance requirements while maintaining design conditions, in accordance with the intent of these specifications.

C. Previous to any performance tests, the Contractor shall have set and adjusted valves, dampers, motors, controllers, thermostats, and other items as are necessary to properly balance phases of the mechanical systems and shall have the systems operating and maintaining design temperatures, humidity, and air circulation throughout all areas of the building.

D. See other sections of these specifications for other possible records and tests to be made.
E. During the first-year warranty, the Contractor may be required to make some or all of the readings above to assure system is functioning properly through the various seasons. Contractor shall make additional adjustments as required.

3.9. PAINTING

A. Provide mechanical equipment with factory painted finish. Where factory finish is damaged during handling and installation, use touch-up paint of same type and color as original paint. Where extensive refinishing of factory applied finishes are required, equipment shall be repainted by the factory.

B. All uninsulated, ferrous equipment, tanks, pipes, fittings, pipe hangers, supports, miscellaneous steel, and ironwork without factory finish shall be primed and painted. Do not paint galvanized hanger rods or galvanized duct straps.
   1. Where exposed to view, except in mechanical spaces, color shall be as selected by the Architect.
   2. Where located in mechanical spaces or in areas not exposed to view, color shall be as directed by Owner’s representative to match Owner’s existing color schedule. In the absence of an Owner’s color schedule, color shall be black.

C. All insulated mechanical equipment, tanks, and piping not provided with a factory finish shall be painted.
   1. Where exposed to view, except in mechanical spaces, color shall be as selected by the Architect.
   2. Where located in mechanical spaces or in areas not exposed to view, color shall be as directed by Owner’s representative to match Owner’s existing color schedule. In the absence of an Owner’s color schedule, color shall be black.

D. For uninsulated material to be painted, prime with one coat of alkyd primer and paint with two coats of alkyd enamel gloss. Paint shall be suitable for the environmental and temperature conditions where material is installed.

E. Paint insulated material with two coats of alkyd enamel gloss. Paint shall be suitable for the environmental and temperature conditions where material is installed.

F. Prepare surfaces for painting in accordance with the paint manufacturer’s requirements. Remove or protect portions of the work which are not to be painted.

G. Apply primer coat(s) of paint as recommended by the paint manufacturer.

H. Apply final coat(s) of paint as recommended by the paint manufacturer. Apply paint by brush or roller as dictated by the surface to be painted. Paint should have a smooth appearance without cloudiness, spotting, marks, runs, or other surface imperfections.

I. Clean-up the area of materials, waste, and rubbish. Clean splattered surfaces.

J. Protect the work from damage. Touch-up and restore defaced painted surfaces at the end of the project.

3.10. NOISE: Contractor shall isolate pipes, ductwork, equipment, and other items to insure no additional noise is generated or transmitted to the building when systems are in operation.
3.11. ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor mechanical materials and equipment. See Paragraph 3.11 for painting.

B. Field Welding: Comply with AWS D1.1.

3.12. OPERATION INSTRUCTIONS

A. Contractor shall provide bound manuals containing complete repair parts' lists, and operating service and maintenance instructions for equipment provided. The manual shall include:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing and instructions and lubrication charts and schedules.

B. Contractor shall carefully instruct the Owner's operations personnel during the adjustment and testing period of the equipment for such length of time as may be necessary to thoroughly familiarize them with the proper care, operation, and maintenance of the equipment.

C. Contractor shall turn special tools, maintenance items, keys, other devices and materials required to operate or maintain the systems over to the Owner.

3.13. CLEAN UP

A. Do not allow waste material or rubbish to accumulate in or about jobsite. Clean work areas daily.

B. At completion of work, remove rubbish, tools, scaffolding, and surplus materials from and about building, leaving work clean and ready for use without further cleaning required. Clean equipment, piping, valves, fixtures, and fittings of grease, metal cuttings, insulation cement, dust, dirt, paper labels, and other materials that are not part of the final finish.

C. Any discoloration or other damage to parts of building, its finish or furnishings due to failure to properly clean or keep mechanical systems clean shall be repaired without cost to Owner.

3.14. NAMEPLATE DATA: Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Where manufacturer’s name plate is not stamped or engraved, provide additional heavy gauge aluminum or brass, stamped or engraved nameplate. Do not remove
manufacturer’s nameplates. When manufacturer’s nameplates are to be covered by insulation or other material, provide a separate nameplate for mounting on the exterior of the covering.

3.15. RECORD DOCUMENTS

A. At completion of this project, the Contractor shall provide Engineer with one set of “red lined” design drawings and specification showing all Work installed by him.

B. These documents shall incorporate all changes made in the course of the project so as to enable the Owner to properly maintain, operate, and repair both exposed and concealed work. The redlines shall indicate changes:

1. Made by Contractor.
2. Addendum Items.
3. Change Orders.
4. Substitutions.

C. Drawings and specifications shall be updated during the progress of the work and kept at the job site.

D. Record Prints: Maintain one set of blue-line or black-line prints of the Contract Drawings, Submittals, and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally.
   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Accurately record information in an understandable drawing technique.
   c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.

3.16. FINAL PROJECT OBSERVATION: The final project observation shall not be made until the following items have been assembled and approved as indicated in other sections of the specifications.

A. Certificate of acceptance from local inspecting authorities.

B. Letter of compliance from the Controls Systems Provider indicating that the system is complete, fully operational, and installed as specified by manufacturer’s certified or licensed individuals.

C. Test and Balance report.


E. Copies of bonds, insurance certificates, waivers, affidavits, warranties and guarantees, and other documents required in the specifications signed and ready for appropriate action.

F. Written notification from the Contractor that the work is complete and ready for final observation and the above documents are completed and available.
G. Other documentation which may be required by the Engineer.

3.17. PROJECT CLOSEOUT

A. The final mechanical systems closeout shall not be completed until the Contractor has completed his work and submitted the documents required by Division 1 portions of the specifications. In addition, the following work items and specific mechanical documents described in other portions of this specification section shall also be submitted and approved:

1. Record drawings.
2. Record specifications.
4. Operating and Maintenance Manuals (O&M). O&M Manuals shall also be provided to the Owner in duplicate. Manuals shall contain approved shop drawings, operations and maintenance instructions, parts manuals for HVAC equipment, an accurate set of design plans showing all construction revisions to the design set, and a copy of the test and balance report.
5. Final clean up.
6. Final Test and Balance Reports with startup logs.
7. Pipe and Equipment Identification.
8. Pipe test certifications.
9. Water treatment analysis and application.
11. Other items which may be required by the Engineer.

B. Confirm in writing that specified training specified has been completed with the Owner.
C. Confirm in writing that specified demonstrations have been completed with the Owner.
D. Confirm that test and balance is complete.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Through-penetration firestopping in fire rated construction.

B. Scope: The scope of the work shall include the mechanical systems, HVAC piping and ductwork, plumbing piping, fire protection piping, and other systems installed by the contractor.

1.2 REFERENCES

A. Underwriters Laboratories
   1. U.L. Fire Resistant Directory
      a. Through-penetration firestop devices (XHCR)
      b. Fire resistance ratings (BXUV)
      c. Through-penetration firestop systems (XHEZ)
      d. Fill, void, or cavity material (XHHW)

B. American Society for Testing and Materials Standards:

1.3 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time rated fire walls, time rated ceiling/floor assemblies, and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.

F. Sleeve: Metal fabrication or pipe section extending through thickness off barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.4 SYSTEM DESCRIPTION

A. Design Requirements
   1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption, and at other construction gaps.
2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations, connections with other surfaces and types of construction and at all separations required to permit building movement and sound or vibration absorption, and at other construction gaps.

1.5 SUBMITTALS

A. Submit in accordance with general conditions unless otherwise indicated.

B. Product data: Manufacturer's specifications and technical data including the following:
   1. Detailed specification of construction and fabrication
   2. Manufacturer's installation instructions.

C. Shop drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.
   1. Details of each proposed assembly identifying intended products and applicable UL System number, or UL classified devices.
   2. Manufacturer or manufacturers' representative shall provide qualified engineering judgements and drawings relating to non-standard applications as needed.

D. Quality control submittals:

E. Applicators' qualifications statement:
   2. List past projects indicating required experience.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for fire resistance ratings and surface burning characteristics.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of combustibility.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when temperature of substrate material and ambient air is below 60 degrees F.

B. Maintain this minimum temperature before, during, and for 3 days after installation of materials.

C. Provide ventilation in areas to receive solvent cured materials.
D. Furnish forced air ventilation during installation if required by manufacturer.
E. Keep flammable materials away from sparks or flame.
F. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
G. Comply with manufacturing recommendations for temperature and humidity conditions before, during and after installation of firestopping.

1.9 SEQUENCING
A. Sequence work to permit firestopping materials to be installed after adjacent and surrounding work is complete.

1.10 QUALITY ASSURANCE
A. Installer’s qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:
   1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
   2. At least 2 years’ experience with systems.
   3. Successfully completed at least 5 comparable scale projects using this system.
B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.
C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

1.11 DELIVERY, STORAGE, AND HANDLING
A. Packing and shipping:
   1. Deliver products in original unopened packaging with legible manufacturer’s identification.
   2. Coordinate delivery with scheduled installation date, allow minimum storage at site.
B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer’s instruction.

1.12 PROJECT CONDITIONS
A. Existing conditions:
   1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
   2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

1.13 GUARANTEE
A. Submit copies of written guarantee agreeing to repair or replace joint sealers which fail in joint adhesion, co-adhesion, abrasion resistance, weather resistance,
extrusion resistance, migration resistance, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be one year from date of substantial completion.

PART 2 - PRODUCTS

2.1 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Systems or devices listed in the U.L. Fire Resistance Director under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the U.L. system or device, and designed to perform this function.

2. Acceptable manufacturers and products: Those listed in the U.L. Fire Resistance directory for the U.L. System involved and as further defined in Part 3.06 of this section.

3. All firestopping products must be from a single manufacturer. All trades shall use products from the same manufacturer.

4. Products shall be 3M firestopping products and systems or equal.

2.2 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-Penetration Smoke-Stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in this section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

B. Construction-Gap Smoke-Stopping: Any system complying with the requirements for construction-gap firestopping in fire-rated construction, as specified in this section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.3 MATERIALS

A. Firestopping Material: Single or multiple component silicone elastomeric rubber type foam compound mixed with incombustible non-asbestos ceramic fibers.

B. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces.

2.4 ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHW in the U.L. Fire Resistance Directory.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
   2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3 INSTALLATION

A. Apply primer and materials in accordance with manufacturer’s instructions.

B. Install penetration seal materials in accordance with printed instruction of the U.L. Fire Resistance Directory and in accordance with manufacturer’s instruction.

C. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

D. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor.

E. Apply firestopping material in sufficient thickness to achieve rating and to a uniform density and texture.

F. Protect materials from damage on surfaces subject to traffic.

G. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit and other items requiring firestopping.

H. Place firestopping in annular space around fire dampers before installation of damper’s anchoring flanges - installed in accordance with fire damper manufacturer’s recommendations.

I. Where large openings are created in walls or floors to permit installation of pipes, ducts, cable tray, bus duct or other items, close unused portions of opening with firestopping material tested for the application. See U.L. Fire Resistance Directory.

J. Install smoke stopping as specified for firestopping.

K. Where rated walls are constructed with horizontally continuous air space, double width masonry, or double stud frame construction, provide vertical 12 inch wide fiber dams for full thickness and height of air cavity at maximum 15 foot intervals.

L. Dam material to remain.
3.4 FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.5 ADJUSTING AND CLEANING

A. Clean adjacent surfaces of firestopping materials.

B. Clean up spills of liquid components.

C. Neatly cut and trim materials as required.

D. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.6 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.7 SYSTEMS AND APPLICATION

A. The installation shall be as required by manufacturer for type of construction, Type of U.L. systems, type of penetration, and type of fire stopping system

END OF SECTION
PART 1  GENERAL

1.1. DESCRIPTION OF WORK

A. This Section describes the demolition, removal, relocation, rerouting and reconnection of existing mechanical facilities, as required, shown and specified herein, to accomplish alteration, restoration and to accommodate new construction.

B. The work shall include but not be limited to, draining, disconnecting, relocating, removing and dismantling, in a neat and workmanlike manner, the items and their accessories as indicated or Shown on the Contract Drawings.

1.2. REFERENCES

A. ANSI A10.6 – Safety Requirements for Demolition
C. NFPA 51B – Cutting and Welding Processes
D. NFPA 70 – National Electrical Code
E. NFPA 241 – Safeguarding Building Construction and Demolition Operations
F. OSHA 29 CRF 1910 – Occupational Safety and Health Standards
G. US EPA – Clean Air Act Amendment of 1990.

1.3. SUBMITTALS

A. Demolition Schedule
B. Fire Watch Procedures
C. Inspection Report of Underground Piping Systems
D. Welding/Burning Permit – Obtain a welding/burning permit from the local Fire Official prior to the start of any welding or burning in accordance with the local Fire Code or as required by the Owner.

1.4. QUALITY ASSURANCE

A. Cutting, patching and removal shall be performed by workers skilled in the specific trades involved.

B. Job Conditions: Prior to start of work, make an inspection accompanied by the Engineer to determine physical condition of adjacent construction that is to remain.

1.5. SPECIAL PRECAUTIONS

A. Torch cutting of ductwork will not be permitted.

B. Torch cutting of other mechanical equipment will be permitted only as indicated by the
Engineer.

C. Any cutting method, which may create sparks, must include “Fire Watch” as required by the Fire Code and/or Owner’s Fire Insurance Carrier. Submit fire watch procedures for approval.

D. Draining operations must not damage building components.

PART 2 PRODUCTS

2.1. Adequately sized rubbish containers for the proper and safe disposal of all debris.

PART 3 EXECUTION

3.1. PREPARATION

A. Construct temporary partitions prior to any demolition work enclosing respective work. Erect temporary fencing and signage around demolished materials. Use water sprinkling and other suitable methods to limit dust and dirt arising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.

B. Protect existing materials and equipment which are not to be demolished.

C. Prevent movement of structure; provide required bracing and shoring.

D. Do not begin the work until the time schedules and manner of operations have been approved by the Engineer and Owner. All interruptions of existing services shall be included in the schedules as approved by the Engineer and Owner.

3.2. GENERAL

A. Provide alteration and demolition of mechanical facilities as required by the contract drawings and specifications. The drawings are diagrammatic and do not show the exact location of all existing mechanical work. Where existing equipment shall remain in service during construction, provide rerouting and reconnection of mechanical services as required to maintain continuous service.

B. Review all equipment with the Engineer and Owner prior to disposal. Existing ductwork, piping, conduit and similar items to be abandoned that are not embedded in walls or floor slabs shall be completely removed unless otherwise shown on the drawings. Cap open ends at all walls and floors.

C. Remove, store and protect all equipment or materials to be reused by the Owner as shown on the drawings. Coordinate exact location of storage with the Owner. Items indicated to be removed, and not designated for Owner’s salvage or for reuse, may be salvaged by Contractor. Transport salvaged items that are not to be reused from site as they are removed. Storage or sale of removed items on site will not be permitted.

D. Temporarily cap ends of ductwork, sanitary piping and sanitary vent piping to avoid entry of dirt, debris, or discharge of foul odors and gases.
E. Where existing louvers or ductwork penetrations are to remain, blank-off the louver on the inside with galvanized sheet metal on both sides of 2-inch thick, 6 pcf density rigid fiberglass board insulation. Paint side attached to the louver with flat black paint.

F. Do not close or obstruct egress width to exits. Conduct demolition operations and removal of debris to ensure minimum interference with roads, streets, walkways, occupied areas, and other adjacent occupied or used facilities. Ensure safe passage of persons around or through area of demolition operations to prevent injury to adjacent buildings, structures, other facilities, and persons.

G. Do not disable or disrupt building fire or life safety systems without five (5) days' prior written notice to the Engineer and Owner.

H. Conform to procedures applicable when discovering hazardous or contaminated materials.

I. Conduct demolition to minimize interference with adjacent building structures or Owner's operations.

J. Cease operations immediately if structure appears to be in danger or hazardous materials are encountered. Notify Architect/Engineer. Do not resume operations until directed.

K. Demolish in an orderly and careful manner. Do not cut or remove more than is necessary to accommodate the new construction or alteration.

L. Remove demolished materials from site daily. Do not burn or bury materials on site. Dispose of all material at an approved disposal facility.

M. Cover and protect floors, furniture, equipment and fixtures to avoid soiling or damage when demolition work is performed in rooms or areas from which such items have not been removed. Protect finished surfaces at all times and repair or replace, if damaged, to match existing construction to the satisfaction of the Engineer.

N. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.

O. Protect new and existing roofs from damage.

P. Do not interrupt existing utilities serving occupied portions of the facility, except when authorized in writing by Owner's representative. Provide temporary services during interruptions to existing utilities, as acceptable to the Owner. Contractor shall disconnect and seal only utilities to be demolished serving areas being demolished, prior to start of demolition work. If Contractor is required to disconnect utility services or other services to an occupied area, the Contractor shall provide temporary or alternative service to that area, as acceptable to the Owner.

3.3. PIPING REMOVAL

A. Cut off all welded piping square at the locations indicated on the drawings. No cutting will be required where the demolition ends at a flanged valve or equipment. Close off all openings of any remaining valves, piping or fittings with weld caps or blind flanges to prevent debris from entering the existing system.
B. Disconnect all threaded piping at the location indicated on the drawings. Close off all openings of remaining valves, piping, fittings and equipment with pipe plugs or pipe caps as required to prevent debris from entering the existing systems.

C. Remove all pipe hangers, supports, miscellaneous steel and anchors with the piping.

3.4. PROTECTION FROM FREEZING

A. It is intended that the building remain protected from damage due to freezing temperatures. To that end, existing equipment and systems used for heating shall remain in place and in operation until scheduling permits shutdown.

B. Where the removal of equipment and/or existing systems will leave an area unprotected from freezing, notify the Owner and Engineer at least 72 hours in advance prior to removal so appropriate steps can be taken by the Owner to protect the area. Provide temporary heating equipment sufficient to prevent freezing.

C. It is the Contractor’s responsibility to ensure that piping systems that are being worked on are completely drained from water prior to the start of demolition. If water is not drained and the piping freezes it is the Contractor’s responsibility to replace piping at his own expense.

3.5. DISCONNECTION AND INTERRUPTION OF MECHANICAL SERVICES

A. When portions of an existing piping system or ductwork system are removed, and this removal causes loss of operation to another piece of equipment due to open (disconnected) piping or ductwork, then cap piping or ductwork or provide temporary piping or ductwork system to retain operation of various systems.

3.6. MECHANICAL EQUIPMENT REMOVAL

A. Remove all mechanical equipment as shown on the Contract Drawings. Remove all electrical work, including wiring between equipment, and wiring to power source or point of origin.

B. Where equipment is supported by steel and/or structural supports, remove these supports.

3.7. REFRIGERANT REMOVAL

A. Recover and dispose of all existing refrigerant charges in accordance with EPA regulations. Release of chlorofluorocarbon refrigerants to atmosphere is prohibited per the Clean Air Act Amendments of 1990.

3.8. DUCTWORK REMOVAL

A. Disconnect all ductwork, which must be removed, at the closest joint and resupport the remaining ductwork.

B. Prepare all remaining ductwork joints at the point of disconnection to receive new ducts or blank-off panels.
C. Remove all ductwork supports and miscellaneous steel with ductwork to be demolished.

3.9. INSULATION REMOVAL

A. Remove insulation, together with all piping, fittings, valves and equipment designated for demolition.

3.10. CONTROL WIRING REMOVAL

A. Disconnect and remove all control wiring and tubing, including conduit, for the Automatic Temperature Control (ATC) System associated with equipment to be removed.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY:

A. This section specifies the basic requirements for electrical components which are to be provided for operation of mechanical equipment. These components include, but are not limited to, motors, starters, and disconnect switches when indicated, furnished as an integral part of packaged mechanical equipment, or furnished separately for mechanical equipment.

B. Furnish all motor controllers and contactors, not furnished as part of a motor control center, for proper operation of all motors.

C. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specification sections and scheduled on the drawings.

1.2 REFERENCES:

A. NEMA Standards MG 1: Motors and Generators.
B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.

1.3 SUBMITTALS:

A. Separate submittal is not required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.4 QUALITY ASSURANCE:

A. Electrical components and materials shall be UL labeled.

B. The electrical work shall comply with the National Electric Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Equipment shall be by same manufacturer, except those items furnished by an equipment manufacturer as an integral part of his equipment. Where possible the equipment shall be by the same manufacturer specified in Division 16.

2.2 MOTORS: The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
A. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

B. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

C. 2-speed motors shall have 2 separate windings on poly-phase motors.

D. Temperature Rating: Rated for 40 degrees C. environment with maximum 90 degree C rise for continuous duty at full load (Class B insulation).

E. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly spaced starts per hour for manually controlled motors.

F. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.


   1. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.

   2. Bearings:
      a. Ball or roller bearings with inner and outer shaft seals.
      b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
      d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.

   3. Enclosure Type:
      a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
      b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
      c. Weather protected Type I for outdoor use, Type II where not housed.

   4. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.

   5. Noise Rating: "Quiet".

   6. Efficiency:
      b. Motors smaller than 1 HP shall have minimum full load efficiencies levels per NEMA Standards.
c. Motors 1 HP and larger shall be premium efficiency.

7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.3 STARTERS, ELECTRICAL DEVICES, AND WIRING:

A. Motor Starter Characteristics:

1. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R or NEMA 12 with conduit hubs installed by contractor, or units in hazardous locations which shall have NEC proper class and division.

2. Type and size of starter shall conform to adopted standards and recommended practices of the National Electric Code and Underwriters’ Laboratories.

B. Manual Switches: Manual switches shall have:

1. Pilot lights and extra positions for multi-speed motors.
2. Overload protection: Melting alloy type thermal overload relays.
3. Manual starters / switches are to be used on fractional horsepower motors only.

C. Magnetic Starters:

1. Momentary contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
2. Trip-free thermal overload relays, each phase.
3. Interlocks, witches and similar devices as required for coordination with control requirements of controls sections.
4. Built-in 120 volt control circuit transformer, with 2 primary and one secondary fuse, where service exceeds 240 volts. Fuses sized to carry holding coil circuit and other connected devices.
5. Externally operated manual reset.
6. Under-voltage release or protection (3-wire control).
7. Branch circuit protection shall meet type 2 coordination protection.
8. A hand-off-auto selector switch shall be provided in addition to start-stop buttons for all devices being controlled automatically.

a. Provide protective relays with DPDT 600V rated contacts, locking potentiometer undervoltage adjustment, and LED indicating light at each starter for motors greater than 5 HP. Equal to Square D Class 8430, Type MPD, mounted in suitable enclosure.

D. Motor Connections:
1. Flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Heater Contactors:

1. Contactors for resistance heat shall be by same manufacturer as starters unless furnished with heaters. Contactors shall be of the magnetic type and mounted in NEMA Type 1 general purpose enclosure. Contactors shall carry a UL listing and shall be rated for 100,000 cycles.

F. Disconnect Switches:

1. Fusible Switches: Fused, each phase; heavy duty; horsepower rated; non-tea- able, quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the “open” position; arc quenchers; capacity and characteristics as indicated.

2. Non-fusible Switches: For equipment less than 1 horsepower, switches shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment 1 horsepower and larger, switches shall be the same as fusible type.

2.4 CAPACITORS:

A. Features:

1. Individual unit cells, all welded steel housing, each capacitor internally fused, non-flammable synthetic liquid impregnant, craft tissue insulation, and aluminum foil electrodes.

2. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load.

PART 3 - EXECUTION

3.1 GENERAL

A. Install motors on motor mounting systems in accordance with motor manufacturer’s instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Deliver starters and wiring devices which have not been factory-installed on equipment unit to electrical installer for installation.

C. Install starters and wiring devices at locations indicated, securely supported and anchored, and in accordance with manufacturer’s installation instructions. Locate for proper operation access, including visibility, and for safety. Do not cover equipment data or informational tags when device is to be mounted on equipment.
D. Install control connections for motors to comply with NEC and applicable provisions of Electrical. Install equipment grounding except where non-grounded isolation of motor is indicated.

E. Connect protective relays to line side lugs of the motor starter and wire control contacts into motor starter circuit.

F. Label starters with engraved plastic nameplate describing the equipment served, e.g., "A.C. Unit No. 1". Nameplates shall be U.V. stabilized for use indoor / outdoor. Attach nameplates with clear silicone sealant.

END OF SECTION
PART 1 - GENERAL

1.1 THERMAL EXPANSION:
Swing joints, turns, expansion loops, and long offsets shall be provided where necessary to allow for expansion and contraction. Pipe, fittings, or equipment damaged during the warranty period due to thermal expansion shall be replaced at no additional cost to the Owner.

1.2 NOISE CONTROL:
Piping shall be free of any objectionable self-generated noise. Isolate piping from building where required to prevent transmission of noise.

1.3 CROSS CONNECTIONS:
No piping shall be installed that will provide a cross-connection between potable water system and a polluted supply.

1.4 SUBMITTALS
A. Product Data: Submit catalog cut sheets and specifications for each type of pipe, tube, and fitting. Submit pipe schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Except for hub and spigot, clay, and similar piping, provide factory applied end caps on all pipe and tubing to prevent damage, and dirt and moisture entry. Maintain end caps through shipping, storage, and handling.
B. Where possible, store pipe, tube, flanges, and fittings inside and protected from the weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

1.6 QUALITY ASSURANCE
A. Qualify and certify welding and brazing procedures, equipment, and operators in accordance with ASME codes and standards for shop and job site work.
B. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
C. Welding procedures and testing shall comply with ANSI Standard B31.1.
D. Soldering and brazing procedures and testing shall comply with ANSI Standard B31.9. Comply with ANSI Standard B31.5 for refrigerant piping.

PART 2 – PRODUCTS

2.1 MATERIALS:
A. Refer to specific piping specification sections for materials to be used on the various piping systems.

B. Materials shall be manufactured by firms whose products of types and sizes required for this project have been in satisfactory use in similar service for 5 years.

C. All materials shall be new and undamaged.

D. For corrosive environments all bare copper piping shall be provided with special Heresite coating even if located within outdoor equipment.

2.2 CONDENSATE: Sch 40 PVC

A. Condensate shall be sloped 1/8" per foot towards condensate pit.

2.3 REFRIGERANT PIPE, INCLUDING LIQUID AND HOT GAS LINES: Type "K" copper, soft-drawn. Soft-drawn may be used where bending is required on 1-3/8" O.D. and smaller. All other shall be Type L "degreased" Copper, hard-drawn, marked "ACR".

A. Soft copper will be permitted when sleeving below grade or installing in wall to eliminate fittings. Soft copper may also be installed on units less than 1 1/2 tons.

B. Do not run refrigerant lines thru return air plenum unless approved by engineer.

C. Do not run refrigerant piping underground.

2.4 JOINING MATERIALS:

A. Refer to specific piping specification sections for special joining materials not listed below.

B. 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 other thickness or specific material is indicated.

2. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

3. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

4. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: approximately 95 percent tin and 5 percent silver, with 0.1 percent lead content.

2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.1 percent maximum lead content.

3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.1 percent maximum lead content.
4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.1 percent maximum lead content.

5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.2 percent maximum lead content.

E. Brazing Filler Metals:
   2. Bag1: Silver Alloy.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements: Manufacturer’s standard solvent cements for the following:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.


I. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.

J. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
   2. Followers: ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 536 ductile iron.
   5. Finish: Enamel Paint.

K. Dielectric Fittings
   1. Provide dielectric connection at all connections between pipe materials of differing types whether indicated on plans or not.
   2. Insulating Material: Suitable for system fluid, pressure, and temperature.
   3. Dielectric Unions: Factory fabricated, union assembly, for 250-psig minimum working pressure at 180 °F.
   4. Dielectric flanges: Factory fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   5. Dielectric-Flange Insulation Kits: Field assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Provide separate companion flanges and steel bolts and
nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.

6. Dielectric couplings: Galvanized steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends, and 300-psig minimum working pressure at 225°F.

7. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; threaded ends, and 300-psig minimum working pressure at 225°F.

2.5 PIPE ESCUTCHEONS:

A. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floor, walls, or ceilings; and pipe sleeve extension, if any. Furnish solid pipe escutcheons with nickel or chrome finish for occupied areas. Prime paint finish for unoccupied areas. Split hinge type is not acceptable in occupied areas, except on existing piping.

B. For waterproof floors and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons.

2.6 PIPE SLEEVES:

A. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3” diameter and smaller, 20 gauge; 4” to 6” diameter, 16 gauge; over 6” diameter, 14 gauge.

B. Steel-Pipe: Fabricate from ASTM A 53, Grade A, Schedule 40 galvanized steel pipe.

C. Iron-Pipe: Fabricate from cast-iron or ductile iron pipe; cast-iron sleeve to be same wall thickness as equivalent ductile iron pipe.

2.7 SLEEVE SEALS:

A. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing water tight seal and electrical insulation. Thunderline, “Link Seal” or equal.

B. Fire Protection Mechanical Sleeve Seals: Three (3) hour rated modular mechanical type, consisting of interlocking fire resistant silicone rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing water tight seal and fire resistant seal. Thunderline, “Link Seal” or equal.

C. Fire Protection Sealant

a. Firestop System installation must meet requirements of ASTM E 814, UL 1479 or UL 2079 tested assemblies and provide a fire rating equal to that of construction being penetrated.

b. All firestop materials and methods shall conform to applicable governing codes having local jurisdiction, whether approved by submittal or not.
c. For those firestop applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar independently tested system designs will be submitted to local authorities having jurisdiction for their review and approval prior to installation.

D. Elastomeric Joint Sealant: Type S, Grade NS, Class 25, Use O, neutral-curing, silicone sealant unless otherwise indicated.

E. Grout: Nonshrink, nonmetallic, hydraulic cement grout, ASTM C 1107, Grade B. Post hardening, volume adjusting, dry, nonstaining, noncorrosive, and nongaseous recommended for interior and exterior applications. 5000 psig, 28 day strength.

PART 3 - EXECUTION

3.1 GENERAL:

A. Install piping as described below, unless indicated otherwise in the individual piping sections. See the individual piping sections for unique piping installation requirements.

B. Exposed lines are to be run parallel with, or perpendicular to, building lines and wherever possible shall be grouped together for easy service and identification. Lines requiring a definite grade for drainage shall have precedence in routing over all other lines. Wherever possible, horizontal and vertical lines shall be held as close as possible to walls, ceilings, struts, and structural members to occupy minimum space consistent with the proper requirements for insulation, expansion, removal of pipe, and access to valves. Except in mechanical spaces, piping shall not be run exposed in finished area of buildings unless otherwise noted.

C. General Locations and Arrangements: Drawings including plans, schematics, and diagrams indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

D. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

E. Install fittings for changes in direction and branch connections.

F. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, and below grade or floors, unless indicated otherwise.

G. Install piping at indicated slopes and as prescribed by Code.

H. Install components with pressure rating equal to or greater than system operating pressure.

I. Install piping free of sags and bends.

J. Install piping with sufficient space above removable ceiling panels to allow for panel removal.

K. Install drains at low points in mains, risers, and branch lines consisting of a branch fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
L. Piping shall be worked into place without springing and/or forcing. Arrange piping so that it does not interfere with removal of other equipment or devices, nor to block access to doors, windows, manholes, or other access openings.

M. All piping shall be installed so as to avoid liquid or air pockets throughout the work. Piping shall be erected and pitched to insure proper draining. Provide air vents and drain traps where indicated and as required.

N. All exposed plumbing fixture supplies and stops shall be chrome-plated.

O. Do not run piping through electrical or electronic equipment spaces and enclosures unless unavoidable. If piping must be run through electrical spaces, comply with NFPA 70 for access clearance requirements for electrical equipment. Install drip pan under piping which must be run through electrical spaces. Pan drain shall be run at exterior or sanitary, as permitted by Code.

P. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.

Q. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained.

3.2 ASSEMBLY:

A. All pipes shall be cut square and shall have burr and cutting slag removed by reaming or other cleaning methods.

B. Remove scale, slag, dirt, and debris from both inside and outside of piping and fittings before assembly.

C. Unions or flanges shall be used at all equipment connections to facilitate dismantling.

D. All joints and changes of direction shall be made with standard fittings. Reducers shall be used at pipe size changes.

E. Where required to prevent electrolysis and corrosion, dielectric fittings and couplings, or brass or bronze fittings or valves, shall be used between copper and steel piping. Provide insulating coupling on all underground metallic utility lines where they connect to building.

F. Nipples shall be of same material and composition as pipe on which they are installed, and shall be extra heavy when unthreaded shoulder is less than 1-1/2". No running thread nipples will be permitted. Minimum exposed shoulder of any nipple shall not be less than 3/4".

G. Joints between steel or copper pipe and cast iron shall be made with caulking ferrules.

H. Cast iron soil pipe and fittings shall be assembled with approved molded push-on type gaskets. Approved no-hub pipe may be used where applicable.

I. Galvanized steel pipe shall be assembled with galvanized screwed fittings.

J. Black steel pipe shall be assembled with screwed or welded fittings.

K. Copper pipe shall be assembled with wrought copper fittings. Use Alloy Sn95 (95/5) solder as a minimum. See specific piping sections for other requirements.
L. For steel piping, use new forged tees for branch connections to main in new piping systems. Forged tees or forged weld-o-lets shall be used for branch connections to existing mains.

M. Soldered Joints: Construct joints according to AWS’s “Soldering Manual”; or CDA’s “Copper Tube Handbook”.

N. Brazed Joints: Construct joints according to AWS’s “Brazing Handbook”.

O. 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. Use appropriate tape or thread compound as required unless dry threading is specified.

P. Welded Joints: Construct joints according to AWS D10.12 using qualified processes and welding operators.

Q. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

R. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. 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. ABS Piping: ASTM D 2235 and ASTM D 2661.
4. PVC Pressure Piping: ASTM D 2672.
5. PVC Nonpressure Piping: ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.

3.3 FITTINGS AND ACCESSORIES:

A. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.

B. Install unions adjacent to each valve at the final connection to each piece of equipment and plumbing fixture having 2” and smaller connections, and elsewhere as indicated.

C. Install flanges in piping 2-1/2” and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

D. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through walls, partitions, and ceilings where penetration is exposed to view; and on the exterior of the building.

3.4 SUPPORTS:
Provide an adequate pipe suspension system in accordance with recognized engineering practices, using, where possible, standard, commercially accepted pipe hangers and accessories. No piping shall be supported by, or from, hangers supporting electrical conduit.
3.5 SLEEVES

A. Install pipe sleeves of types indicated where piping passes through walls, floors, slabs, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as directed by the Structural Engineer.

B. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than two (2) pipe sizes larger than piping run. Where insulation includes vapor barrier jacket, provide sleeve with sufficient clearance for insulation.

C. Install length of sleeve equal to the thickness of construction penetrated, and finished flush to surface; except extend floor sleeves 1 inch above level floor finish.

D. Sleeves are not required for core-drilled holes.

E. Permanent sleeves are not required for holes formed by removable plastic sleeves.

F. Provide temporary support of sleeves during placement of concrete and other work around sleeves. Provide temporary closure to prevent concrete and other materials from entering sleeves.

G. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings for pipe diameter including insulation (if any) of 6 inches and larger.

H. Install iron-pipe sleeves at exterior penetrations, both above and below grade and for slab on grade penetrations.

I. Install steel-pipe sleeves at interior partitions for pipe diameter including insulation (if any) of less than 6 inches.

J. Seal voids between outside of sleeve and construction with nonshrink, nonmetallic grout.

K. Sleeves Seals:
   1. Provide sleeve seals for core drilled holes and holes made using removable plastic sleeves.
   2. Provide mechanical sleeve seals for exterior wall, floor, and slab on grade applications. Install in accordance with manufacturer’s recommendations for a water tight seal. Except for slab on grade and below grade wall penetrations, elastomeric joint sealants may be used in lieu of mechanical sleeve seals.
   3. Provide fire mechanical sleeves seals for penetrations of rated walls, slabs, floors, and ceilings. Fire protection sealants complying with all authorities having jurisdiction may be used in lieu of mechanical type seals.
   4. Sleeve seals are not required in non-rated interior partitions and ceilings.

3.6 CLEANING, FLUSHING, INSPECTION:
Clean exterior surfaces of installed piping systems and prepare for application of coating and painting (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each length for completion, supports, and accessories.

3.7 TESTING:
A. Test all piping systems as hereinafter specified and furnish to the Engineer copies of the test reports signed by the Contractor.

B. Piping located underground shall be tested and inspected by the governing agency before backfilling.

C. Equipment and personnel required for tests shall be furnished without additional cost. Testing equipment shall be as required for particular test, with all equipment and gauges accurate and in good working order.

D. Equipment subject to damage at given test pressure shall be removed from line before pressure is applied. Use proper plugs or caps.

E. Repair piping system sections which fail the required test, by disassembly and re-installation, using new materials. Do not use chemicals, stop-leak, mastics, or other temporary repair methods. Retest the system.

F. Drain test water after testing and repair work has been completed.

G. See specific piping system sections for test pressure, duration and medium.


END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following mechanical identification applications:

1. Equipment identification.
2. Pipe identification.
3. Valve tags.
4. Valve schedule.
5. Duct identification.

1.2 SUBMITTALS

A. Product Data: For each type of product proposed.

B. Product Schedule: Provide schedule indicating each type of identification material to be used for equipment, piping, and ductwork. Indicate colors to be used.

C. Valve Schedule: Submit a valve schedule for each piping system, typewritten and reproduced on 8-1/2” x 11” bond paper. Provide three (3) copies. Mark valves which are intended for emergency shut-off, normally open, normally closed, and similar special uses by special flag in the margin of the schedule. Include the following for each valve:
   1. Valve identification number.
   2. System.
   3. Purpose.
   4. Location.
   5. Type.
   7. Manufacturer.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, “Scheme for the Identification of Piping Systems”, for letter size, length of color field, for colors not included in the schedule herein, and for viewing angles of identification devices for piping.

1.4 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 location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS
2.1 EQUIPMENT IDENTIFICATION

A. Engraved Plastic Laminate Identification Signs

1. General: Provide engraving stock melamine plastic laminate in the sizes and thicknesses indicated, with engraver’s standard letter style, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where using adhesive mounting.

2. Thickness: 1/16” for units up to 20 inches square or 8” length; 1/8” for larger units.

3. Fasteners: Self tapping stainless steel screws except use contact-type, permanent adhesive where screws cannot or should not penetrate the substrate. Where sign cannot be attached directly to device or equipment, attach with brass chain.

4. Letter sizes: Minimum ¼ inch for names of units if viewing distance is less than 24 inches, ½ inch for viewing distances up to 72 inches, and proportionally larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

2.2 PIPE IDENTIFICATION

A. All above grade piping shall be identified with pipe markers with colors as indicated. Identification shall have proper legend and meet OSHA specifications. Comply with ASME A13.1, unless otherwise noted.

B. For piping where diameter including insulation is less than 8”, pipe markers shall be plastic, pre-tensioned, semi-rigid type that encircles entire pipe without the use of adhesives. Tape and sticker types are unacceptable.

C. For piping where diameter including insulation is 8” or greater, pipe markers shall be plastic, full-band, semi-rigid type strapped to pipe using manufacturer’s standard stainless steel bands.

D. Underground line markers: Manufacturer’s standard permanent, bright colored, continuous printed, plastic tape intended for direct burial service, not less than 6” wide and 4 mils thick. Provide tape with printing which most accurately indicates the type of buried pipe.

E. Manufacturer: Pipe markers as manufactured by Seton, Brady, Brimar, or EMED are acceptable.

F. Identification Schedule:

<table>
<thead>
<tr>
<th>Piping System</th>
<th>Legend</th>
<th>Band/Text Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water</td>
<td>Cold Water</td>
<td>Green/White</td>
</tr>
<tr>
<td>Hot Water</td>
<td>Hot Water</td>
<td>Yellow/Black</td>
</tr>
<tr>
<td>Hot Water Return</td>
<td>Hot Water Return</td>
<td>Yellow/Black</td>
</tr>
</tbody>
</table>

Specification No. 203.600
Page 2 of 5
2. **Sanitary Sewer System**

<table>
<thead>
<tr>
<th>Sanitary Waste</th>
<th>Sanitary Sewer</th>
<th>Green/White</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Vent</td>
<td>Sanitary Vent</td>
<td>Green/White</td>
</tr>
</tbody>
</table>

G. Arrows and lettering shall be black. Arrows shall point in the direction of flow. Locate downstream of pipe legend.

H. Arrows shall be of same color as bands and shall point in direction of flow. Locate downstream of pipe legend.

I. Valve Identification: Provide brass tags for all valves and steam traps with legend describing function of each valve and trap. Tag shall also indicate normally open or normally closed, where position is noted on the drawings.

J. Valve Tags: Brass tags shall be a minimum of 2" diameter or 3-1/2" oval, to accommodate 1" high numbers. Tag shall be equipped with a 3/16" X 6" long brass chain.

### 2.03 DUCT IDENTIFICATION

A. **Engraved Plastic Laminate Identification Signs**

1. General: Provide engraving stock melamine plastic laminate in the sizes and thicknesses indicated, with engraver’s standard letter style, colored black background with white letters except as otherwise indicated.

2. Thickness: 1/16" for units up to 20 inches square or 8" length; 1/8" for larger units.

3. Fasteners: Contact-type, permanent adhesive.

4. Letter sizes: Minimum ¼ inch for names of units if viewing distance is less than 24 inches, ½ inch for viewing distances up to 72 inches, and proportionally larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

B. **Stencils:** As specified and indicated herein.

### 2.04 STENCILS: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4" for ducts; and minimum letter height of ¾" for equipment and access door signs. Use alkyd paint. Use stencils only as directed herein.

### PART 3 - EXECUTION

#### 3.01 EQUIPMENT IDENTIFICATION

A. Provide permanent, factory, operational data, nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an
accessible location. Where manufacturer’s nameplate is not stamped or engraved, provide additional heavy gauge, aluminum or brass, stamped or engraved nameplate. Do not remove manufacturer’s nameplates. When manufacturer’s nameplates are to be covered by insulation or other material, provide a separate nameplate for mounting on the exterior of the covering.

B. In addition to factory nameplate, provide an engraved plastic laminate (stenciled) identification sign for each major item of mechanical equipment and each operational device. Provide identification signs for the following general categories of equipment.

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets or steam relief valves.
2. Chillers, cooling towers, condensing units, compressors, pumps, and similar motor-driven units.
3. Heat exchangers, coils, and similar equipment.
4. Fans and blowers.
5. Packaged and central-station type air units.
6. Tanks and pressure vessels.
7. Strainers, filters, humidifiers, water treatment systems, and similar equipment.
8. Control panels.
9. Fuel burning units, such as boilers, furnaces, and heaters.
10. Fire department hose valves and hose stations.

C. Provide engraved sign at each access door, indicating equipment or device to be accessed.

D. Coordinate names, abbreviations, and other designations used in equipment identification with corresponding designations shown, specified, scheduled, or as designated by the Owner’s representative. Provide numbers, lettering, and wording as indicated or as directed by the Owner’s representative. Owner shall set priority for lettering and graphics. Where multiple systems of the same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, AHU-1H, Standpipe G14).

3.02 PIPE IDENTIFICATION

A. Provide 1” thick molded fiberglass insulation with jacket under each plastic pipe marker to be installed on uninsulated pipes where fluid temperatures will be 125°F or greater. Insulation shall extend 4” beyond edges of marker.

B. Valve tags and steam traps shall be numbered as indicated on the valve listing provided to the Owner.

C. See Section 15050 for piping to be painted.

D. As a minimum, identification shall be applied to piping at the following locations:
   1. Adjacent to each valve.
   2. At each branch and riser take-off.
   3. At each pipe passage through wall, floor, and ceiling construction.
   4. At each pipe passage to underground.
   5. At not more than forty feet spacing on straight pipe runs.
6. For medical gas piping, at intervals of not more than 20 feet, at least once in each room, and at least once at each story traversed by the pipeline.

E. Place identification so it can be easily read. Arrows shall be applied to indicate direction of flow.

F. Underground Piping: During back-filling of each exterior underground piping system, install plastic line marker, located directly over buried line no deeper than 8” below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16”, install a single line marker.

3.03 DUCTWORK IDENTIFICATION

A. Identify ductwork using stenciled signs. Letter color for stenciled signs shall be either white or black. Provide the color that produces the most contrast with the covering being stenciled. Indicate direction of flow, air handling unit or fan, air terminal box, and duct service (such as supply, return, and exhaust).

B. Apply ductwork identification at the following locations:
   1. Adjacent to each damper.
   2. At each passage through walls, floors, or ceiling construction.
   3. At no more than forty feet intervals.
   4. At air handling units, fans, and air terminal boxes

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Perform all Work required to provide and install piping insulation, jackets, and accessories indicated by the Contract Documents with supplementary items necessary for proper installation.

B. Insulation of Underground Piping is specified elsewhere and not work of this Section.

1.02 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:
   1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
   5. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
   8. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
  10. ASTM C552 - Cellular Glass Thermal Insulation.
  12. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
  14. ASTM C450 - Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
  15. ASTM C610 - Molded Expanded Perlite Block and Pipe Thermal Insulation.
  17. ASTM C1126 - Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
  21. ASTM C795 - Insulation For Use Over Austenitic Steel.
1.03 DEFINITIONS

A. Concealed: Areas that cannot be seen by the building occupants.

B. Interior Exposed: Areas that are exposed to view by the building occupants, including underneath countertops, inside cabinets and closets, and all equipment rooms.

C. Interior: Areas inside the building exterior envelope that are not exposed to the outdoors.

D. Exterior: Areas outside the building exterior envelope that are exposed to the outdoors, including building crawl spaces and loading dock areas.

E. Unconditioned Space: Interior space that is not temperature-controlled by cooling and/or heating system. Includes attics, chases, unconditioned living spaces and non-conditioned equipment rooms.

1.04 QUALITY ASSURANCE

A. All piping requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.

B. All insulation, jacket, adhesives, mastics, sealers, and accessories utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement.
   1. Certificates to this effect shall be submitted along with submittal data.
   2. No material shall be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application Company Qualifications: Company performing the Work of this Section shall have minimum three (3) years experience specializing in the trade.

D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.

E. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, damaged or water-soaked Work will not be acceptable.
F. Stainless Steel: Insulation applied on stainless steel shall meet requirements of ASTM C795 and NRC 1.36. These requirements are for prevention of external stress corrosion cracking (ESCC) for austenitic stainless steel.

1.05 SUBMITTALS

A. Prepare a schedule of piping insulation showing systems insulated. For each system, show insulation type, thickness, temperature rating, and special conditions where applicable.

B. Submit product data for each piping system. Product data shall include but not be limited to the following:
   1. Manufacturer's name
   2. Insulation material and thickness
   3. Jacket
   4. Adhesives
   5. Fastening methods
   6. Fitting materials
   7. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
   8. Insulation installation details (manufacturer's installation instructions/details, Contractor's installation details, MICA plates where applicable)
   9. Other appropriate data

C. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.

D. Operation and Maintenance Data: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the Project Site in original factory packaging, labeled with manufacturer's identification including product thermal ratings and thickness.

B. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. Insulation:
   1. Owens-Corning
2. Certainteed Corporation
3. Johns Manville Corporation
4. Knauf Corporation
5. Armstrong/Armacell (Armaflex)
6. RBX Industries/Rubatex
7. FOAMGLAS (Cellular Glass) by Pittsburgh Corning

B. Jackets:
1. Childers Products Company
2. PABCO
3. RPR Products, Inc.
4. John Mansfield Speedline
5. Foamglas

C. Coatings, Sealants, and Adhesives:
1. Foster
2. Childers

2.03 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. 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.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Piping Insulation Type P1: Glass-Fiber, Preformed Pipe Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A with factory applied ASJ-SSL vapor barrier jacket with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Provide one of the following:
   1. Owens Corning; Evolution Fiberglas Pipe Insulation.
   2. Johns Manville; Micro-Lok Pipe Insulation.
   3. Knauf; Earthwool 1000 degree Pipe Insulation.

F. Piping Insulation Type P2: Flexible Elastomeric Pipe Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Provide one of the following:
   1. Armacell LLC; AP Armaflex
   2. Aeroflex USA Inc; Aerocel
   3. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

G. Piping Insulation Type P3: Handicap Lavatory and Sink Piping Insulation Kit:
1. Handicap lavatory and sink drain piping, P-trap, cold and hot water assemblies and valves shall be insulated with fully molded insulation kit specifically designed for handicap lavatories and sinks. ADA conforming.

2. Material shall be 3/16" thick molded closed cell vinyl with nylon fasteners, white finish and be self-extinguishing per ASTM D635, with K value of 1.17 BTU/in./hr./sq. ft./deg. F.

H. Piping Insulation Type P4: Preformed Cellular Glass: Comply with ASTM C 585, ASTM C 450. Provide one of the following:

   1. Pittsburgh Corning; Foamglas

2.04 FIELD-APPLIED FABRIC-REINFORCING MESH

A. 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. Provide one of the following:

   1. Foster Brand, Specialty Construction Brands, Inc; Mast-A-Fab.
   2. Vimasco Corporation; Elastafab 894.

2.05 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Piping Jacket Type J1: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 40 mil thickness, roll stock ready for shop or field cutting and forming. Provide factory-fabricated fitting covers to match jacket. Provide one of the following

   1. Johns Manville; Zeston.
   2. Proto Corporation; LoSmoke

C. Piping Jacket Type J2: Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14. Provide factory-fabricated fitting covers or field fabricate covers only if factory-fabricated fitting covers are not available. Provide one of the following:

   1. Provide Childers Brand Metal Jacketing Systems.
   2. Provide shop fabricated smooth aluminum jacket 0.016".

2.06 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

2.07 INSULATION INSERTS

A. Provide insert between support shield and piping on piping 1 1/2" diameter or larger. Inserts shall be factory fabricated of heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
   1. 1 1/2" to 2 1/2" pipe size 10" long
   2. 3" to 6" pipe size 12" long
   3. 8" to 10" pipe size 16" long
   4. 12" and over 22" long

2.08 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12-inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

F. Adhesives: Compatible with insulation.

G. Banding:
   1. Aluminum bands, 3/4" x 0.02 inches
   2. Stainless Steel, 304, 3/4" by 0.02 inches

PART 3 - EXECUTION

3.01 PREPARATION

A. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping shall be completely dry at the time of application. Insulating piping where condensate is occurring is unacceptable. Wet insulation is unacceptable and shall be removed and replaced before acceptance by the Owner.

B. Coordinate insulation installation with trade installing heat trace. Comply with requirements for heat tracing that apply to insulation.

C. Verify that piping has been tested for leakage before applying insulation.
3.02 GENERAL INSTALLATION REQUIREMENTS

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards, and shall conform to codes and ordinances of authorities having jurisdiction.

B. Installation of insulation and jacket materials shall be in accordance with manufacturer’s published instructions.

C. Handle and install materials in accordance with manufacturer’s instructions in the absence of specific instructions herein.

D. On exposed piping, locate insulation cover seams with the ridge of the lap joint is directed down.

E. Provide dams in insulation at intervals not to exceed 20 feet on cold piping systems to prevent migration of condensation or fluid leaks. Indicate visually where the dams are located for maintenance personnel to identify and also provide dams at butt joints of insulation at fittings, flanges, valves, and hangers.

F. 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.

G. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

H. 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.

I. Install insulation with longitudinal seams at top and bottom of horizontal runs.

J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

K. Keep insulation materials dry during application and finishing.

L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

M. Install insulation with least number of joints practical.

N. 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.

O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

P. 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.
   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.
   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.

Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.

T. 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.
   5. Handholes.
   6. Cleanouts.

3.03 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. Comply with requirements in Section 15050 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 Section 15050.

3.04  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, 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 where concealed unions, check valve or piping specialties are insulated. Provide descriptive label at device under the insulation. For example at each union stencil 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.

3.05 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.

### 3.06 INSTALLATION OF GLASS-FIBER PREFORMED PIPE 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 below-ambient surfaces, 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 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 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.

3.07 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive. 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.

3.08 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Do not field paint aluminum jackets.

3.09 PIPING SYSTEMS INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>Service</th>
<th>Insulation Type</th>
<th>Location</th>
<th>Jacket Type</th>
<th>Pipe Size</th>
<th>Insulation Thickness by Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLD PIPING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Cold Water</td>
<td>P1</td>
<td>Interior Concealed</td>
<td>--</td>
<td>0.5” and smaller</td>
<td>0.5”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.0” through 2.0”</td>
<td>1.0”</td>
</tr>
<tr>
<td>Refrigerant Suction</td>
<td>P2</td>
<td>Interior Concealed</td>
<td>--</td>
<td>3.0” and smaller</td>
<td>0.75”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.0” and larger</td>
<td>1.0”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interior Exposed</td>
<td>J1</td>
<td>3.0” and smaller</td>
<td>0.75”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.0” and larger</td>
<td>1.0”</td>
</tr>
<tr>
<td></td>
<td>Space</td>
<td>Exterior J2</td>
<td>Equipment Rooms J1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------</td>
<td>-------------</td>
<td>---------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unconditioned</td>
<td>3.0&quot; and smaller</td>
<td>3.0&quot; and smaller</td>
<td>3.0&quot; and smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.75&quot;</td>
<td>0.75&quot;</td>
<td>0.75&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0&quot; and larger</td>
<td>4.0&quot; and larger</td>
<td>4.0&quot; and larger</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unconditioned</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cool Bell Condensate P2</td>
<td>Interior Concealed --</td>
<td>3.0&quot; and smaller</td>
<td>3.0&quot; and smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>--</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch Lines</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0&quot; and larger</td>
<td>4.0&quot;</td>
<td>4.0&quot; and larger</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.75&quot;</td>
<td>0.75&quot;</td>
<td>0.75&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Bell Condensate</td>
<td>Interior Exposed J1</td>
<td>3.0&quot; and smaller</td>
<td>3.0&quot; and smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td>0.5&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain Main Lines</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0&quot; and larger</td>
<td>4.0&quot;</td>
<td>4.0&quot; and larger</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.75&quot;</td>
<td>0.75&quot;</td>
<td>0.75&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HOT PIPING**

<table>
<thead>
<tr>
<th></th>
<th>Domestic Hot Water P1</th>
<th>Interior Concealed --</th>
<th>Interior Exposed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.5&quot; and smaller</td>
<td>0.5&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot;</td>
<td>1.0&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot; through 2.0&quot;</td>
<td>1.0&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5&quot; and larger</td>
<td>1.5&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5&quot; and smaller</td>
<td>0.5&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Location</td>
<td>Diameter</td>
<td>Insulation Thickness</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>1.0&quot; through 2.0&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5&quot; and larger</td>
<td></td>
<td>1.5&quot;</td>
<td></td>
</tr>
<tr>
<td>Unconditioned</td>
<td></td>
<td>0.5&quot; and smaller</td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td></td>
<td>1.0&quot; through 2.0&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5&quot; and larger</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5&quot;</td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td>0.5&quot; and smaller</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot; through 2.0&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5&quot; and larger</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0&quot;</td>
<td></td>
</tr>
<tr>
<td>Equipment Rooms</td>
<td>J1</td>
<td>0.5&quot; and smaller</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot; through 2.0&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5&quot; and larger</td>
<td></td>
</tr>
<tr>
<td>Domestic Hot Water and Drain at</td>
<td>P3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handicap Lavatories</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerant Hot Gas</td>
<td>P2</td>
<td>Interior Concealed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>--</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0&quot; and smaller</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.75&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.0&quot; and larger</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&quot;</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Diameter Range</td>
<td>Insulation Thickness</td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>Interior Exposed</td>
<td>3.0&quot; and smaller</td>
<td>0.75&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0&quot; and larger</td>
<td>1.0&quot;</td>
<td></td>
</tr>
<tr>
<td>Unconditioned</td>
<td>3.0&quot; and smaller</td>
<td>0.75&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0&quot; and larger</td>
<td>1.0&quot;</td>
<td></td>
</tr>
<tr>
<td>Equipment Rooms</td>
<td>3.0&quot; and smaller</td>
<td>0.75&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0&quot; and larger</td>
<td>1.0&quot;</td>
<td></td>
</tr>
<tr>
<td>below 7.0&quot; above floor</td>
<td>4.0&quot; and larger</td>
<td>1.0&quot;</td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 GENERAL

1.01. WORK INCLUDED
   A. Inserts, Anchors, and Upper Attachments
   B. Pipe Hangers, Rods, Supports, and Accessories
   C. Fabricated Steel Support

1.02. QUALITY ASSURANCE
   A. Design of pipe supporting elements shall be in accordance with ANSI B31.1
   B. Fabrication and installation of pipe hangers and supports shall be in accordance with the following Manufacturers Standardization Society (MSS) Standards:
      1. SP-58 Pipe Hangers and Supports: Materials, Design and Manufacture.
      2. SP-69 Pipe Hangers and Supports: Selection and Application.
   C. Steel angles, channels and plate shall be in accordance with ASTM A36, red primed or hot dipped galvanized for interior applications and hot galvanized for exterior applications.
   D. Bolts, including nuts and washers, used for fabricating steel members shall be in accordance with ASTM A325 and shall be stainless steel or plated for corrosion protection. Plain steel components are unacceptable.
   E. Welding of steel members shall be in accordance with AWS D1.1.
   F. Steel supports for ducts, pipe anchors, pipe guides, and piping supported from below shall be fabricated in accordance with AISC Specification for the Design, Fabrication and Erection of Structural Steel for buildings. If required, the Contractor shall include the cost of the services of a structural engineer to design or review the system.

1.03. APPLICABLE PUBLICATIONS
   A. Applicable sections of the publications listed below form a part of this Section. The publications are referenced by the basic designation only.
      1. American Institute of Steel Construction (AISC)
      2. American National Standards Institute (ANSI)
      3. American Society for Testing and Materials (ASTM)
      4. American Welding Society (AWS)
      5. The Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)
      6. National Fire Protection Agency (NFPA)
7. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA)

1.04. SUBMITTALS

A. Submit schedule indicating type of hanger to be used by system and pipe size. Include rod size for each hanger size.

B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.

C. Provide shop drawings for fabricated steel supports.

PART 2 PRODUCTS

2.01. ACCEPTABLE MANUFACTURERS

A. Inserts, Anchors, and Upper Attachments:

1. Anvil International, Inc.
2. Carpenter Paterson, Inc.
3. Cooper B-Line, Inc.
4. Elecen Metal Products
5. Hilti
6. Unistrut
7. ITW Red Head

B. Pipe Hangers, Rods, Supports and Accessories:

1. Anvil International, Inc.
2. Carpenter Paterson, Inc.
3. Cooper B-Line, Inc.
4. Elecen Metal Products
5. Hilti
6. Unistrut

C. Fabricated Steel Support: As indicated on Drawings.

2.02. DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions. Provide 4-to-1 safety factor.
B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction, and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.3.
   2. MSS SP-58 and MSS SP-69.
   3. Except where modified by this Specification.

E. For steam and hot and cold water piping, design, materials of construction and installation pipe hangers, supports, guides, restraints and anchors:
   1. ASME B31.1
   2. MSS SP-58 and MSS SP-69.

F. Check all physical clearances between piping, support system, and structure. Provide for vertical adjustment after erection.

G. Support vertical pipe runs in pipe chases at base of riser. Support pipes for lateral movement with clamps or brackets.

H. Place hangers on outside of pipe insulation. Use a pipe covering protection saddle for insulated pipe at support point.

I. Fabricated Steel Supports: As detailed on the drawings.

2.03. INSERTS AND ANCHORS

A. Inserts: MSS Type 18; malleable iron body and nut, galvanized finish, opening in top of insert for reinforcing rod, lateral adjustable.

B. Anchors: Steel shell and expander plug, snap off end fastener

2.04. HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Select size of hangers and supports to exactly fit pipe size for bare piping, and around piping insulation with saddle or shield for insulated piping.

B. For suspension of non-insulated or insulated stationary pipe lines: Adjustable steel clevices, MSS Type I.

C. For suspension of non-insulated stationary pipe lines: Adjustable band hangers, MSS Type 7 or 9; or split pipe rings, MSS Type II.

D. For support of piping where horizontal movement due to expansion and contraction may occur, and where a low coefficient of friction is desired: Pipe slides and slide plates, MSS Type 35, including guided plate mounted on a concrete pedestal or structural steel support.

E. For support from floor stanchion, using floor flange to secure stanchion to floor: Adjustable pipe stanchion saddles, MSS Type 37 or 38, including steel pipe base support and cast-iron floor flange.
F. For suspension of pipe from two (2) rods where longitudinal movement due to expansion and contraction may occur: Adjustable roller hangers, MSS Type 43.

G. For suspension of pipe from a single rod where horizontal movement due to expansion and contraction may occur: Adjustable roller hangers, MSS Type 43.

H. For support of pipe from a single rod where vertical adjustment is not necessary: Pipe roll stands, MSS Type 45.

I. For support of pipe where small horizontal movement due to expansion and contraction may occur, but vertical adjustment is not necessary: Pipe rolls and plates, MSS Type 45.

J. For support of pipe lines where vertical and lateral adjustment during installation may be required in addition to provision for expansion and contraction: Adjustment pipe rolls stands, MSS Type 46.

2.05. VERTICAL PIPING CLAMPS

A. Select size of vertical piping clamps to exactly fit size of bare pipe.

B. For support and steadying of pipe risers: Two-bolt riser clamps, MSS Type 8 or 42.

2.06. HANGER ROD ATTACHMENTS

A. Select size of hanger rod attachments to suit hanger rods.

B. For adjustment up to six (6) inches for heavy loads: Steel turnbuckles, MSS Type 13.

C. For use on high temperature piping installations: Steel clevices, MSS Type 14.

D. For use with split pipe rings, MSS Type II: Swivel turnbuckles, MSS Type 15.

E. For attaching hanger rod to various types of building attachments: Malleable iron sockets, MSS Type 16 or 17.

F. Rods:

1. Size 3/8" and up: All thread steel rod electro galvanized. Sizing for pipe or equipment support as follows:

<table>
<thead>
<tr>
<th>Copper Tube, Plastic</th>
<th>Steel, Cast Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Size (Copper, Plastic)</td>
<td>Pipe Size (Steel, Cast Iron)</td>
</tr>
<tr>
<td>1/4&quot; to 2&quot;</td>
<td>1/4&quot; to 2&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; to 4&quot;</td>
<td>2-1/2&quot; to 3&quot;</td>
</tr>
<tr>
<td>6&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>8&quot; to 12&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>14&quot;</td>
<td>8&quot; to 12&quot;</td>
</tr>
<tr>
<td>16&quot;</td>
<td>14&quot; to 16&quot;</td>
</tr>
</tbody>
</table>
2. Rods may be reduced one size for double rod hangers with 3/8" minimum diameter, or when other paragraphs require a minimum of 2 hangers per section, provided the minimum diameter of 3/8" is maintained.

G. For upper attachment for suspending pipe hangers from concrete: Concrete inserts MSS Type 18.

H. For attachment to top flange of structural shape: Top beam C-clamps, MSS Type 19.

I. For attachment to bottom flange of structural shape: Side beam or channel clamps, MSS Type 20 or 27.

J. For attachment to center of bottom flange of beams: Center beam clamps, MSS Type 21.

K. For attachment to bottom of beams where heavy loads are encountered and hanger rod sizes are large: Welded attachments, MSS Type 22.

L. For attachment to structural shapes: C-clamps, MSS Type 23.

M. For attachment to top of beams when hanger rod is required tangent to edge of flange: Top I-beams clamps, MSS Type 25.

N. For attachment to bottom of steel I-beams for heavy loads: Steel I-beam/WF-beam clamps with eye nut, MSS Type 28 or 29.

O. Steel brackets, for indicated loading:
   1. Light duty, 750 pounds, MSS Type 31.
   2. Medium duty, 1,500 pounds, MSS Type 32.
   3. Heavy duty, 3,000 pounds, MSS Type 33.

P. For use on sides of steel beams: Side beam brackets, MSS Type 34.

2.07. SPRING HANGERS AND SUPPORTS

A. Select spring hangers and supports to suit pipe size and loading.

B. For control of piping movement: Restraint control devices, MSS Type 47.

C. For light loads where vertical movement does not exceed 1-1/4 inch: Springs cushion hangers, MSS Type 48.

D. For equipping Type 41 roll hanger with springs: Spring cushion roll hangers, MSS Type 49.

E. For retardation of sway or thermal expansion in piping systems: Spring way braces, MSS Type 50.

F. For absorbing expansion and contraction of piping system from hanger: Variable spring hangers, MSS Type 51; preset to indicated load and limit variability factor to 25%.

G. For absorbing expansion and contraction of piping system from base support: Variable spring base supports, MSS Type 52; preset to indicated load and limit variability factor to
H. For absorbing expansion and contraction of piping system from trapeze support: Variable spring trapeze hangers, MSS Type 53; preset to indicated load and limit variability factor to 25%.

I. Constant supports: Provide one of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.
   1. Horizontal Type: MSS Type 54.
   2. Vertical Type: MSS Type 55.
   3. Trapeze Type: MSS Type 56.

2.08. SUPPLEMENTARY SUPPORTS

A. Where support spacing is more frequent than distance between structural members, provide steel angles, channels or beams sized to provide a deflection of less than 1/240 of span when fully loaded, to transfer pipe support loads to structural members.

B. Where deflection of center of trapeze support exceeds 1/240 of distance between hanger rods, provide additional hanger rods.

C. Where multiple risers are supported within shafts, provide steel angles, channels or beams, sized to provide a deflection of less than 1/240 of span when fully loaded, to transfer loads to the concrete floor slab. Anchor supplemental supports to the slab, and provide resilient element where required by other Sections of this Division.

2.09. ACCESSORIES

A. Protective Shields, MSS Type 40: Carbon steel, galvanized minimum of 12” length sized for required insulation.

B. Protective Saddles, MSS Type 39: Carbon steel plate, minimum of 12” length, sized for required insulation.

C. Steel Turnbuckle, MSS Type 13: Forges steel, galvanized finish with locknuts. Rated at a minimum of 730 lbs. at 3/8” size.

D. Steel Clevis, MSS Type 14: Forged steel, galvanized finish with steel pin and cotter pin. Rated for a minimum of 730 lbs. at 3/8” size.

E. Weldless Eye Nut, MSS Type 17: Forges steel, galvanized finish. Rated for a minimum of 730 lbs. at 3/8” size.

2.10. PIPE INSULATION HANGER SHIELDS

A. Where hangers are placed outside the jackets of pipe insulation, provide shields equal to “Thermal Hanger Shields” as manufactured by Pipe Shields, Inc. or equivalent by Elcen Metal Products Company.

B. Shields shall consist of a 360-degree insert of high-density, 100 psi, waterproof calcium silicate, encased in a 360-degree galvanized sheet steel shield. Insert shall be same thickness as adjoining pipe insulation, and shall extend 1 inch beyond sheet metal shield in each direction on cold lines. Shield lengths and minimum sheet metal gauges shall be as directed below:
C. Shields shall be Model CS-CW, except for pipe roller applications: then provide Model CSX-CW.

D. At the Contractor's option, shop-fabricated galvanized metal shields may be provided based on approved shop drawings. Length and gauge of sheet metal shall be as specified above.

E. For all insulated piping 4” and larger, provide insulation insert at a minimum of 12” long. Insert shall extend a minimum of one inch beyond shield. Insulation inserts shall be minimum 12” long section of foam glass insulation.

### TABLE 2.1.1

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>SHIELD LENGTH</th>
<th>MINIMUM GAUGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” to 1-1/2”</td>
<td>4”</td>
<td>26</td>
</tr>
<tr>
<td>2” to 6”</td>
<td>6”</td>
<td>20</td>
</tr>
<tr>
<td>8” to 10”</td>
<td>9”</td>
<td>16</td>
</tr>
<tr>
<td>12” to 18”</td>
<td>12”</td>
<td>16</td>
</tr>
<tr>
<td>20” &amp; Larger</td>
<td>18”</td>
<td>16</td>
</tr>
</tbody>
</table>

**METAL FRAMING:** Provide products compliant with NEMA ML-1.

**STEEL PLATES, SHAPES AND BARS:** Provide products compliant with ANSI/ASTM A-36.

**PIPE GUIDES:** Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base, with a two-section guiding spider bolted tight to pipe or as shown on Drawings. Size guides and spiders to clear pipe, cylinder and insulation, if any. Provide guides of length recommended by manufacturer to allow indicated travel.

## PART 3  EXECUTION

### 3.01. GENERAL REQUIREMENTS

A. Where applicable, install in accordance with the manufacturer's written installation instructions.

B. Where supports are in contact with copper pipe, provide copper plated support.

C. Where supports are in contact with glass, aluminum or brass pipe, provide plastic coating on supports.

D. Interior hangers, supports, including attachments, that are plain steel shall be primed and painted.

E. Hangers and supports, including attachments, exposed to weather or located in utility tunnels or accessible utility trenches or subject to spillage shall be hot dip galvanized after fabrication.

F. Fabricated steel supports exposed to weather or located in utility tunnels and accessible utility trenches or subject to spillage shall be primed and painted. Cut, welded, drilled or otherwise damaged surfaces of coating shall be repaired.

### 3.02. PREPARATION

---

Specification No. 203.600
Page 7 of 10
A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including but not limited to proper placement of inserts, anchors and other building structural attachments.

3.03. INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, clamps and attachments to support piping properly from building structure in compliance with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together in trapeze-type hangers where possible. Install supports with maximum spacing as specified in this Section. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for small diameter pipe. Do no use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Support fire protection water piping independently of other piping

D. The location of hangers and supports shall be coordinated with the structural work to ensure that the structural members will support the intended load.

E. Provide hex head nut on rod at top and bottom of clevis hanger yoke, and at each rod connection to intermediate and upper attachment. Rod nuts shall be securely locked in place.

F. Hanger rods shall be subject to tensile loading only. Where lateral or axial movement is anticipated, use suitable linkage in hanger rod to permit swing.

G. Hangers shall be fabricated to permit adequate adjustment after erection while still supporting the load. Turnbuckles shall be provided where required for vertical adjustment of the piping.

H. Supports for vertical piping shall be located at each floor or at intervals of not more than 15 feet and at intervals of not more than 8 feet from end of risers. Where supports are provided on intermediate floors spaced 15 feet or less between floors, no additional supports are required other than those specified for end of risers.

I. A hanger or support shall be provided adjacent to each piece of equipment to ensure that none of the pipe weight is supported from the equipment.

J. Provide protective shields on all piping required to be insulated.

K. Provide protective saddles sized to match insulation thickness on all hot piping required to be insulated. Fill void between saddle and pipe with insulation as specified.

L. Provide turnbuckles on all hangers that require leveling or aligning.

M. Provide steel clevis where detailed and/or required.

N. Provide weldless eye nuts on hanger terminations where disassembly or swing may be required. Use in combination with steel clevis.

O. Supports
1. Provide additional supports at:
   a. Changes in direction.
   b. Branch piping and runouts over 5 feet.
   c. Concentrated loads due to valves, strainers and similar items.
   d. At valves 4 inches and larger in horizontal piping.
   e. Support piping on each side of valve.
   f. Brace hubless piping to prevent horizontal and vertical movement.
   g. Where number of grooved couplings exceeds 3 between supports or provide continuous steel between supports.

2. Sanitary waste and vent, roof drains per UPC Section 316: Vertical supports are not required within 2.5 feet of wall penetrations for pipes 8 inches in diameter and smaller, and not more than 3 feet for 10 inches and larger.

3. Other piping support spacing shall be as scheduled on Drawing or as required by referenced standard.

3.04. **HANGER SPACING**

A. The maximum spacing between pipe supports for straight runs shall be in accordance with the following chart. If any deviation from the table exists within the manufacturer's written installation instruction, whichever spacing reflecting the smaller centerline to centerline dimension shall be used.

MAXIMUM HORIZONTAL PIPE HANGER AND SUPPORT SPACING TABLE

1. **Steel Pipe (Schedule 40 & 80):**
   - Up to 1": 7 ft. on center
   - 1-1/4" and greater: 10 ft. on center

2. **Copper Pipe (Types L, K and M):**
   - Up to 1" size: 5 ft. on center
   - 1-1/4" to 2-1/2": 7 ft. on center
   - 3" and larger: 10 ft. on center

3. **Ductile Iron and Cast Iron:** Two hangers per section length.

4. **Polyvinyl Chloride (PVC):**
   - Up to 1-1/2": 3 ft. on center
   - 2" to 4": 4 ft. on center
   - 5" to 8": 5 ft. on center
   - 10" and larger: 6 ft. on center

5. **Sprinkler and Standpipe:** Pipe hangers to be as per NFPA-13 and NFPA-14 standards.

B. Hanger centerline spacing shall be reduced by 50% in areas of concentrated valves and/or fittings, also no more than a maximum distance of 12 inches from valves, fittings and/or couplings, or 24 inches from a change in direction.

3.05. **ATTACHMENT TO STRUCTURE**

A. For plain steel devices, prime and paint.

B. Adjust attachment location for proper alignment and no more than 4 degrees offset from a perpendicular alignment.
C. If proper alignment cannot be achieved from the existing building structure, provide a trapeze type support sized to handle the design load with a minimum safety factor of 5.

3.06. INSERTS

A. Contractor shall have inserts at site and dimensional location drawings ready at the beginning of the involved concrete work.

B. Install inserts by securing to concrete forms and inserting reinforcing rod through the opening provided in the insert in accordance with shop drawings.

C. Provide necessary supervision while concrete is being poured to correct any misalignment caused by the concrete.

3.07. INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B-31, and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bards to piping and to structure. Comply with ANSI B-31, with AWS standards, and with the Details shown on the drawings.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer’s written instructions to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required, accommodating both expansion and contraction of piping.

E. Size anchor shell length to assure a minimum of 1” solid concrete remaining from shell and to concrete face.

3.08. INSTALLATION OF TRAPEZES OR PIPE RACKS

A. Light/Medium Duty: Assemble from standard manufactured metal framing systems, in accordance with manufacturer’s recommendations.

B. Heavy Duty: Fabricate from structural steel shapes selected for loads required. Weld steel in accordance with AWS standards.

3.09. AUXILIARY STEEL

A. Furnish all miscellaneous structural members necessary to hang or support ductwork, piping, and mechanical equipment.

B. Notify Engineer of any adjustment necessary in main structural system for proper support of major equipment.

C. Fabricated Steel Supports: Steel for supports shall be saw cut, with sharp edges ground smooth. After fabrication, remove all foreign material, including welding slag and spatter, and leave ready for painting.

END OF SECTION
PART 1 - GENERAL

1.1 Provide required insulation for HVAC ductwork and plumbing piping.

1.2 All ductwork and piping is insulated unless otherwise noted.

1.3 SUBMITTALS

A. Submit product data for each system. Product data shall include but not be limited to the following:
   1. Manufacturer's name
   2. Insulation material and thickness
   3. Jacket
   4. Adhesives
   5. Fastening methods
   6. Fitting materials
   7. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
   8. Insulation installation details (manufacturer's installation instructions/details, Contractor's installation details, MICA plates where applicable)
   9. Other appropriate data

1.4 QUALITY ASSURANCE

A. All ductwork and piping requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.

B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this Section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application Company Qualifications: Company performing the Work of this Section must have a minimum of three (3) years' experience specializing in the trade.

D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.

E. All insulation shall be applied in strict accordance with these Specifications and with adequate factory-printed recommendations on items not herein mentioned. Unsightly, inadequate, damaged or water-soaked Work will not be acceptable.
PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 HVAC PIPING:

A. Condensate Drain (Above Ground): Armstrong's "Armaflex AP" pipe insulation, 1/2" thick.

B. Refrigerant
   1. Insulate with "Armaflex AP" pipe insulation, 1/2" thick for the following:
      a. All Suction Lines.
      b. Mixed Phase lines for ductless split systems.
      c. Suction and Liquid lines for dedicated 100% outside air split systems.

C. Hydronic piping: 2" thick F.G. with ASJ and molded fittings, 1-1/2" thick through 2" pipe size, and 2" thick for piping 2-1/2" and larger.

2.3 MANUFACTURERS

A. CertainTeed Corporation.
B. Johns Manville Corporation.
C. Knauf Corporation.
D. Owens-Corning.
E. Unifrax 1 LLC (FyreWrap).
F. Armacell

2.4 INSULATION MATERIALS

A. Type D1: Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.

B. Type D2: Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.

C. Type D3: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable acrylic surface coating specifically formulated to:
   1. Be no more corrosive than sterile cotton when tested in accordance with the test method for corrosiveness in ASTM C665.
   2. Absorb no more than 3 percent by weight when tested in accordance with the test method for moisture vapor sorption in ASTM C1104.
3. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM C1071, ASTM C1338, ASTM G21, and ASTM G22.

4. Show no signs of warpage, cracking, delaminating, flaming, smoking, glowing, or any other visibly negative changes when tested in accordance with the test method for temperature resistance in ASTM C411.

5. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.

6. Meet the sound absorption requirements when tested in accordance with the test method for sound absorption in ASTM C423.

7. Show no evidence of continued erosion, cracking, flaking, peeling, or delamination when tested in accordance with the test method for erosion resistance in UL181.

D. Type D4: Fire Rated Grease Duct Insulation (High Temperature Flexible Blanket); 1-1/2-inch thick refractory grade fibrous fire barrier material with minimum service temperature design of 2,000 degrees F; aluminum foil laminated on both sides; with a minimum ‘k’ value of 0.25 and a minimum density of 6 lbs/cu ft; containing no asbestos. Listed by a nationally recognized testing laboratory (NRTL) UL to meet ASTM E 2336, ASTM E119, and with flame spread/smoke minimum rating of 25 / 50 when tested as per ASTM E84/UL 723.

E. Type D5: Outdoor Duct Insulation (Closed Cell Flexible Elastomeric Insulation); 1 inch thick material that has a service temperature range from –60 degrees F to 180 degrees F. This outdoor duct insulation meets ASTM C 177 or C 518 and shall have minimum ‘k’ value of 0.27 Btu-in. / hr-ft2- degrees F at minimum density measurement of 3 lb/cu ft. The insulation and outside surface must be protected with a white Thermo Plastic Rubber Membrane formulated to:

1. Be resistant to UV, and ozone, acid rain, and physical elements produced from outdoor weather per ASTM E 96 Procedure A.
2. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
3. Show no evidence of continued erosion, delaminating, cracking, flaking, or peeling when tested in accordance with the test method for erosion resistance in UL181. Be resistant to mold growth resistance, ASTM G 21/C 1338 resistant to fungi, and resistant to bacteria growth per ASTM G 22.

F. Type D6: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, ‘k’ value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable polyacrylate copolymer emulsion specifically formulated to:

1. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM D 5590 with “0” growth rating.
2. Act as a fungicidal protective coating: water based, VOC < 50 g/l. Fungicidal coating must be EPA registered for use in HVAC duct systems. Manufacturer: H.B. Fuller Construction Products Inc., Foster 40-20 (white) or 40-30 (black) Fungicidal Protective Coating or approved equal. Coatings may also be used to repair damage to duct liner insulation.

G. High Density Duct Insulation Insert, see Type D2.
2.5 INSULATION ACCESSORIES

A. Adhesives: Waterproof vapor barrier type, meeting requirements of ASTM C916; Childers CP-82 or Foster 85-20/85-60.


C. Vapor Barrier Coating: Permeance - ASTM E 96, Procedure B, 0.08 perm or less at 45-mil dry film thickness, tested at 100F and 50%RH; Foster 30-65 or Childers CP-34
   1. When higher humidity levels may be of concern, only specify the following fungus/mold resistant coating: Foster 30-80 AF (anti-fungal). Coating must meet ASTM D 5590 with 0 growth rating**

D. Reinforcing Mesh: 10x10 or 9x8 glass mesh; Foster Mast a Fab or Childers #10

E. Jacket: Pre-sized glass cloth, minimum 7.8 oz/sq yd.

F. Type D4 Insulation Adhesive: Fire resistive to ASTM E84, Childers CP-82 or Foster 85-20.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Joint Tape: Glass fiber cloth, open mesh.

I. Tie Wire and Wire Mesh: Annealed steel, 16 gage.

J. Stainless Steel Banding: 3/4-inch wide, minimum 22 gage, 304 stainless.

K. Armaflex 520, 520 BLV, or Foster 85-75 contact adhesive.

L. Armatuff 25 white seal seam tape.

PART 3 - EXECUTION

3.1 GENERAL

A. The application of all insulation shall be performed by experienced mechanics, regularly employed in the trade, in a neat and workmanlike manner. Unless otherwise specified to a greater quality, the application of all insulation shall be in accordance with the manufacturer's recommendations.

B. Omit insulation from the following items:
   1. Exposed plated plumbing pipe.
   2. Vents to atmosphere, discharge from safety and relief valves, overflow pipes, and hot only drain pipes.
   3. Valves, unions, flanges, traps, strainers, and devices in HOT ONLY piping.

C. Foil-Faced (FF) Duct Insulation shall comply with NFPA Standards 90A and 90B.

D. All exposed ends of pipe insulation shall be pointed up neatly with appropriate insulating cement, or use pre-molded PVC end caps on cold only piping and preformed aluminum end caps on dual-temp, hot or steam piping.
E. Provide high density insert at duct hangers. Maintain vapor barrier between insulation and duct hanger. Do not insulate duct hangers or supports.

3.2 DUCT AND PIPE PREPARATION

A. Verify that piping and ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

C. Maintain required ambient temperature during and after installation for a minimum period of 24 hours.

3.3 ARMAFLEX PIPE INSULATION

A. Apply in strict accordance with latest edition of Armstrong's "Installation Instructions to the Contractor". Joints and seams shall be sealed moisture tight without gaps and openings in the insulation.

3.4 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Extend duct insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated.

D. Provide external insulation on all round ductwork connectors to ceiling diffusers and on top of diffusers as indicated in the Ductwork Insulation Application and Thickness Schedule and the Drawings. Secure insulation to the top of ceiling diffusers with UL181B-FX listed polypropylene duct tape. Do not insulate top of ceiling diffuser if it is used in ceiling return air plenum or in an open space with no ceiling.

E. Flexible and Rigid fiberglass insulation (Types D1 and D2) application for exterior of duct:
   1. Secure flexible insulation jacket joints with vapor barrier adhesive, tape. Tape shall be UL181B-FX listed polypropylene duct tape.
   2. Install without sag on underside of ductwork. Use 4-inch wide strips of adhesive on 8-inch centers and mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
   3. Insulate standing seams and stiffeners that protrude through the insulation with 1-1/2 inch thick, unfaced, flexible blanket insulation. Cover with reinforcing mesh and coat with vapor barrier finish coating.
   4. On circumferential joints, the 2-inch flange on the facing shall be secured with 9/16 inch outward clinch steel staples on 2-inch centers, and taped with minimum 3-inch wide strip of glass fabric and finish coating.
   5. Vapor seal all seams, joints, pin penetrations and other breaks with vapor barrier coating reinforced with reinforcing mesh.
F. Duct Liner (Type D3 or D6) application for interior of return air sound boots or return air plenums:
   1. Secure insulation with 100 percent coverage of duct liner adhesive, pins and clips not more than 18 inches on center.
   2. Secure bottom of duct insulation using alternate single and double clips. The first pin will secure the insulation and the second clip will be used to secure the cladding. Isolate the exterior clip from the cladding by using two 1/8 inch closed cell neoprene (Armaflex) washers on either side of the cladding. Predrill holes in cladding and avoid contact with pin during installation.
   3. For round duct, secure insulation with 100 percent coverage of duct liner adhesive. Secure cladding with 3/4 inch, 0.020 inch stainless steel bands on 12-inch centers.
   4. For joints and overlaps, fold cladding to form a double thickness hem 2 inches minimum. Seal with a non-shrink, non-hardening sealing compound.
   5. Type D6: Provide fungicidal coating in air handlers ten feet on either side, first ten feet downstream of cooling coils, ten feet downstream of mix boxes, in mechanical rooms or as otherwise specified in potentially high humidity areas in the duct system shall be coated with an fungicidal coating; EPA registered for use in HVAC duct systems at a coverage rate of 80 ft²/gallon.

G. Insulation (Type D4) application for exterior of grease ducts:
   1. External duct wrap system requires two (2) 1.5-inch layers of lightweight, flexible wrap overlapped to provide an effective fire barrier. The barrier is installed in 24-inch or 48-inch wide sections. Insulation pins are welded in certain locations to maintain the fire barrier material up against the duct.
   2. Grease duct doors to be installed so the door can be removed and reinstalled and meet code requirements.
   3. Install duct wrap as tested per manufacturer’s instructions to assure the duct wrap is mechanically attached per the manufacturer’s spacing of bands or weld pins.
   4. Vertical and horizontal members of the support hanger system shall be wrapped with one layer of the insulation. Vertical and horizontal portions shall be wrapped independent of one another. The horizontal hanger shall be removed from the vertical support rods and wrapped and then immediately replaced so that an adjacent horizontal support can be removed, wrapped, and reinstalled. The end of the threaded vertical rod shall extend 6-inch past the horizontal member at the beginning of the installation.
   5. Penetrations: Where ducts penetrate fire rated walls, floors and roofs, the duct wrap shall be used in conjunction with a firestop system that is listed by a nationally recognized laboratory and rated for penetration of a rated wall or floor by the fire rated grease duct system used.

H. Insulation (Type D5) application for outdoor ducts:
   1. Horizontal ductwork located outdoors shall be sloped at a minimum 2-degree angle to prevent the accumulation of water on top of the finished insulated duct. Support members that connect directly to the ductwork are to be insulated with this same material. Keep compression or sharp creases of outdoor insulation to a minimum by distributing the weight of the duct resting on horizontal duct support members.
   2. Follow the insulation manufacturer’s installation instructions and procedures to assure the ductwork is properly insulated and that the insulation will meet the manufacturer’s warranty requirements.

I. All ductwork, accessories, and all plenums including metal and masonry construction, etc., shall be insulated as indicated on the Drawings, as specified herein and as
required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

J. Flexible ductwork connections to equipment shall not be insulated.

K. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

L. Extreme care shall be taken in insulating high and medium pressure ductwork including all ductwork between the fan discharge and all mixing boxes to ensure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these Specifications are classified as high velocity ductwork.

M. Where canvas finish is specified use lagging adhesive/coating to prevent mildew in securing canvas. Do not use wheat paste. Use only anti-fungal lagging adhesive that adheres to ASTM D 5590 with 0 growth rating. (Foster 30-36AF, Childers CP-137AF). In addition, cover all exterior canvas-covered insulation with a fire retardant weather barrier mastic.

N. All supply ductwork in the Project shall be insulated; all exhaust and fume hood exhaust ductwork shall not be insulated, unless used for energy recovery purposes or noted on drawings.

O. Flexible round ducts shall be factory insulated.

3.5 INSPECTION

A. Visually inspect the completed insulation installation per manufacturers recommended materials, procedures and repair or replace any improperly sealed joints.

B. Where there is evidence of vapor barrier failure or "wet" insulation after installation, the damaged insulation shall be removed, duct surface shall be cleaned and dried and new insulation shall be installed.

3.6 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

<table>
<thead>
<tr>
<th>Ductwork System</th>
<th>Application</th>
<th>Insulation Type</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Air</td>
<td>Outside of Mechanical</td>
<td>D1</td>
<td>2&quot;</td>
</tr>
<tr>
<td>(Hot, Cold, Combination)</td>
<td>Rooms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inside of Mechanical</td>
<td>D2</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>Rooms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return Air, Relief Air, and</td>
<td>All</td>
<td>D1</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Exhaust Air</td>
<td>All</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Air</td>
<td>Treated and Untreated</td>
<td>D1</td>
<td>2&quot;</td>
</tr>
<tr>
<td>Kitchen Grease Hood Exhaust Air</td>
<td>All</td>
<td>D4</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Duct mounted coils</td>
<td>Inside of Mechanical</td>
<td>D2</td>
<td>2&quot;</td>
</tr>
<tr>
<td></td>
<td>Rooms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal Unit Heating Coils</td>
<td>All</td>
<td>D1</td>
<td>2&quot;</td>
</tr>
<tr>
<td>Ductwork System</td>
<td>Application</td>
<td>Insulation Type</td>
<td>Insulation Thickness</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------------------</td>
<td>-----------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Supply Air Diffusers</td>
<td>Top of Diffuser</td>
<td>D1</td>
<td>2&quot;</td>
</tr>
<tr>
<td>Supply Air Duct</td>
<td>Outdoor Environment</td>
<td>D5</td>
<td>2&quot;</td>
</tr>
<tr>
<td>Return, Exhaust Air Duct</td>
<td>Outdoor Environment</td>
<td>D5</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Return Air Sound Boots/Elbows/Return Air Plenums</td>
<td>All</td>
<td>D6</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.01 Do not vent refrigerants to the atmosphere. Install new systems using recovering methods. Evacuate and recover existing systems to be modified or removed.

1.02 Submit piping materials, fittings, and refrigeration accessories.

PART 2 - PRODUCTS

2.01 REFRIGERANT PIPING:

A. Pipe: Type "K" copper, soft-drawn. Soft-drawn may be used where bending is required on 1-3/8" O.D. and smaller. All other shall be Type "L" Copper, hard-drawn, marked "ACR".

B. Fittings: Wrought copper or forged brass for refrigerant use.

PART 3 - EXECUTION

3.01 REFRIGERANT PIPING:

A. To be installed by machine mechanics skilled in this type work, and in accordance with recognized industry standards.

B. Make joints with "Sil-Fos" backed with nitrogen.

C. Piping and specialties to be sized and installed as recommended by the manufacturer of refrigerant piping.

D. Pre-charged lines may be used with approval of Engineer. These lines shall be installed as recommended by the unit manufacturer. Check and adjust charge after installation.

E. Isolate piping from building structure to prevent transmitting equipment vibration.

F. Installation:

1. Minimum Requirements: Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.

2. Testing:

   a. General: Every refrigerant containing part of every system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation,
and before operation. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively.

b. Test Medium: Oxygen, or any combustible gas, or combustible mixture of gases shall not be used within the system for testing. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-relief device, and a gage on the outlet side. Set the pressure-relief device above the test pressure but low enough to prevent permanent deformation of the system components.

c. System Test and Charging: Recommended by the equipment manufacturer or as follows:

1) Connect source or refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 10 psig. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.

2) Connect a source of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Refer to Table For Test Pressures. Test entire system again for leaks.

3) Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in microns. Pull the system down to 100 microns and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

END OF SECTION
PART 1 GENERAL

1.1. VARIABLE REFRIGERANT VOLUME (VRV / VRV-S) AIR CONDITIONING MODEL DATA: Heat Recovery/Heat Pump Indoor Units

A. Size Range:
   1. 0.6 to 8 Tons Nominal

B. Daikin Model Number:
   1. FXFQ_T INDOOR UNIT – ROUND FLOW SENSING CEILING CASSETTE UNIT
   2. FXZQ INDOOR UNIT – 4 WAY CEILING CASSETTE UNIT (2’x2’)
   3. FXDQ INDOOR UNIT – SLIM DUCT CONCEALED CEILING UNIT

1.2. QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995/CAN/CSA-C22.2 No. 236-05 (R2009) – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).

C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

D. The outdoor unit will be factory charged with R-410A.

1.3. DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

PART 2 WARRANTY

2.1. STANDARD LIMITED WARRANTY

A. Daikin North America LLC warrants original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the “Products”) will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the “installation date” which is one of the two dates below:

   1. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit’s rating plate.

   2. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

B. Complete warranty details available from your local Daikin representative or at www.daikincomfort.com.
PART 3 PERFORMANCE

3.1. DESIGN BASIS

A. The HVAC equipment basis of design is Daikin. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event the contractor shall be responsible for all specified items and intents of this document without further compensation.

PART 4 PRODUCTS

4.1. FXFQ_T – ROUND FLOW SENSING CEILING CASSETTE UNIT

A. General: Daikin indoor unit model FXFQ_T shall be a round flow ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, direct drive DC (ECM) type fan, for installation into the ceiling cavity equipped with an air panel grill. It shall be available in capacities from 7,500 Btu/h to 48,000 Btu/h.

B. Model numbers are FXFQ07TVJU, FXFQ09TVJU, FXFQ12TVJU, FXFQ15TVJU, FXFQ18TVJU, FXFQ24TVJU, FXFQ30TVJU, FXFQ36TVJU, FXFQ48TVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model.

C. It shall be a round flow air distribution type, fresh white, impact resistant decoration panel, or optional self-cleaning filter panel. The supply air is distributed via four individually motorized louvers. To save energy and optimize occupancy comfort, the indoor unit shall be equipped with built in occupancy sensor and surface temperature sensor. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72, BRC1E73, BRC2A71 and BRC1E52B7. The indoor units sound pressure shall range from 30 dB(A) to 45 dB(A) at High speed measured at 5 feet below the unit.

D. Performance: Each unit’s performance is based on nominal operating conditions:

E. Indoor Unit:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Cooling (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)</th>
<th>Heating (Indoor 47°F DB / 43°F WB, Outdoor 70°F DB, 25 ft pipe length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FXFQ07TVJU</td>
<td>7,500</td>
<td>8,500</td>
</tr>
<tr>
<td>FXFQ09TVJU</td>
<td>9,500</td>
<td>10,500</td>
</tr>
<tr>
<td>FXFQ12TVJU</td>
<td>12,000</td>
<td>13,500</td>
</tr>
<tr>
<td>FXFQ15TVJU</td>
<td>15,000</td>
<td>16,500</td>
</tr>
<tr>
<td>FXFQ18TVJU</td>
<td>18,000</td>
<td>20,000</td>
</tr>
<tr>
<td>FXFQ24TVJU</td>
<td>24,000</td>
<td>27,000</td>
</tr>
<tr>
<td>FXFQ30TVJU</td>
<td>30,000</td>
<td>34,000</td>
</tr>
<tr>
<td>FXFQ36TVJU</td>
<td>36,000</td>
<td>40,000</td>
</tr>
<tr>
<td>FXFQ48TVJU</td>
<td>48,000</td>
<td>54,000</td>
</tr>
</tbody>
</table>
1. The Daikin indoor unit FXFQ_T shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

3. Both refrigerant lines shall be insulated from the outdoor unit.

4. The round flow supply air flow can be field modified to 23 different airflow patterns to accommodate various installation configurations including corner installations.

5. Return air shall be through the concentric panel, which includes a resin net, mold resistant, antibacterial filter.

6. The indoor units shall be equipped with a condensate pan with antibacterial treatment and condensate pump. The condensate pump provides up to 33-1/2" of lift from bottom of unit to top of drain piping and has a built in safety shutoff and alarm.

7. The indoor units shall be equipped with a return air thermistor.

8. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.

9. The voltage range will be 253 volts maximum and 187 volts minimum.

10. To save energy and optimize occupancy comfort, the indoor unit shall be equipped with built in occupancy sensor and surface temperature sensor.

11. Supplied air shall be directed automatically by four individually controlled louvers.

F. Unit Cabinet:
   1. The cabinet shall be space saving and shall be located into the ceiling.
   2. Four auto-adjusted louvers shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
   3. The airflow of the unit shall have the ability to shut down outlets with multiple patterns allowing for simpler installation in irregular spaces.
   4. Fresh air intake shall be possible by way of Daikin’s optional fresh air intake kit.
   5. A branch duct knockout shall exist for branch ducting of supply air.
   6. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
   7. Optional high efficiency air filters are available for each model unit.

G. Fan:
   1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.08 to 0.16 HP.

3. The airflow rate shall be available in three manual settings.

4. The DC fan shall be able to automatically adjust the fan speed in 5 speeds based on the space load.

5. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with the high efficiency air filter options.

6. The fan motor shall be thermally protected.

H. Filter:
   1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin and antibacterial treatment.
   2. Optional high efficiency disposable air filters shall be available.
   3. Optional Self-Cleaning Filter Panel, which performs automatic filter cleaning up to once a day, with dust collection box that indicates when to be emptied.

I. Coil:
   1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   3. The coil shall be a 2, or 3-row cross fin copper evaporator coil with up to 21 FPI design completely factory tested.
   4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4 inch outside diameter PVC.
   5. A condensate pan with antibacterial treatment shall be located under the coil.
   6. A thermistor will be located on the liquid and gas line.

J. Electrical:
   1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

K. Control:
   1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
   2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

4. For the Sensing functions and the optional Self-Cleaning Filter functions, Remote controller BRC1E73/BRC1E52B7 shall be used. Consult with Daikin prior to applying controls.

L. Optional Accessories Available:
   1. A high efficiency disposable air filter kit
   2. Air intake kit
   3. Self-Cleaning Filter Panel, which performs automatic filter cleaning up to once a day, with dust collection box that indicates when to be emptied.
   4. Remote “in-room” sensor kit (KRC01-4B).
      a. The Daikin wall mounted, hard wired remote sensor kit is recommended for when a NAV controller is not used or when the NAV controller is not located in the space that is being controlled. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

4.2. FXZQ – 4 WAY CEILING CASSETTE UNIT (2’x2’)

A. General: Daikin indoor unit model FXZQ shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be available in capacities from 7,500 Btu/h to 18,000 Btu/h. Model numbers are FXZQ07MVJU9, FXZQ09MVJU9, FXZQ12MVJU9, FXZQ15MVJU9, FXZQ18MVJU9 to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. It shall be a four-way air distribution type, white (RAL9010), impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72, BRC1E73 and BRC2A71. The indoor units sound pressure shall range from 29 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.

B. Performance: Each unit’s performance is based on nominal operating conditions:

C. Indoor Unit:
   1. The Daikin indoor unit FXZQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Cooling (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)</th>
<th>Heating (Indoor 47°F DB / 43°F WB, Outdoor 70°F DB, 25 ft pipe length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FXZQ07MVJU9</td>
<td>7,500</td>
<td>8,700</td>
</tr>
<tr>
<td>FXZQ09MVJU9</td>
<td>9,500</td>
<td>11,100</td>
</tr>
<tr>
<td>FXZQ12MVJU9</td>
<td>12,000</td>
<td>14,000</td>
</tr>
<tr>
<td>FXZQ15MVJU9</td>
<td>15000</td>
<td>17,500</td>
</tr>
<tr>
<td>FXZQ18MVJU9</td>
<td>18,000</td>
<td>21,000</td>
</tr>
</tbody>
</table>
proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

3. Both refrigerant lines shall be insulated from the outdoor unit.

4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.

5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.

6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21” of lift and has a built in safety shutoff and alarm.

7. The indoor units shall be equipped with a return air thermistor.

8. All electrical components are reached through the decoration panel, which reduces the required side service access.

9. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.

10. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:
1. The cabinet shall be space saving and shall be located into the ceiling.

2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.

3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.

4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.

5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:
1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.

2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.

3. The airflow rate shall be available in high and low settings.

4. The fan motor shall be thermally protected.

F. Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

G. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.

3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.

4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.

5. A condensate pan shall be located under the coil.
6. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.

7. A thermistor will be located on the liquid and gas line.

H. Electrical:
1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

I. Control:
1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

J. Optional Accessories Available:
1. Direct fresh air intake kit (KDDQ44X60).
2. Supply air duct connections.
   i. The Daikin wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

4.3. FXDQ – SLIM DUCT CONCEALED CEILING UNIT

A. General: Daikin indoor unit model FXDQ shall be a Slim, built-in ceiling concealed fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity. The unit shall be constructed of a galvanized steel casing. It shall be available in capacities from 7,000 Btu/h to 24,000 Btu/h.

B. Model numbers are FXDQ07MVJU, FXDQ09MVJU, FXDQ12MVJU, FXDQ18MVJU, and FXDQ24MVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. It shall be a horizontal discharge air with horizontal return air or bottom return air configuration. All models feature a very low height (7-7/8”) making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72, BRC1E73 and BRC2A71. Included as standard equipment, a long-life filter that is mold resistant and a condensate drain pan and drain pump kit that pumps to 23-5/8” from the drain pipe opening. The indoor units sound pressure level shall range from 29 dB(A) to 32 dB(A) at low speed and 33 dB(A) to 36 dB(A) at high speed 5 feet below the suction grille.

C. Performance: Each unit’s performance is based on nominal operating conditions:
D. Indoor Unit:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Cooling (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)</th>
<th>Heating (Indoor 47°F DB / 43°F WB, Outdoor 70°F DB, 25 ft pipe length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FXDQ07MVJU</td>
<td>7,500</td>
<td>8,500</td>
</tr>
<tr>
<td>FXDQ09MVJU</td>
<td>9,500</td>
<td>10,500</td>
</tr>
<tr>
<td>FXDQ12MVJU</td>
<td>12,000</td>
<td>13,500</td>
</tr>
<tr>
<td>FXDQ18MVJU</td>
<td>18,000</td>
<td>20,000</td>
</tr>
<tr>
<td>FXDQ24MVJU</td>
<td>24,000</td>
<td>27,000</td>
</tr>
</tbody>
</table>

1. The Daikin indoor unit FXDQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have adjustable external static pressure capabilities.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

3. Both refrigerant lines shall be insulated from the outdoor unit.

4. Return air shall be through a resin net mold resistant filter.

5. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 23-5/8" of lift from the center of the drain outlet and has a built in safety shutoff and alarm.

6. The indoor units shall be equipped with a return air thermistor.

7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.

8. The voltage range will be 253 volts maximum and 187 volts minimum.

9. Switch box shall be reached from the side or bottom for ease of service and maintenance.

E. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.

2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

F. Fan:

1. The fan shall be direct-drive Sirocco type fan, statically and dynamically balanced impeller with high and low fan speeds available.

2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 62W to 130W.

3. The airflow rate shall be available in high and low settings.

4. The fan motor shall be thermally protected.

5. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

6. Fan motor external static pressure range for nominal airflow:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Fan ESP (in. WG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
G. Filter:
   1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

H. Coil:
   1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   3. The coil shall be a 2 or 3-row cross fin copper evaporator coil with 14 FPI design completely factory tested.
   4. The refrigerant connections shall be flare connections and the condensate will be 1-1/32" outside diameter PVC.
   5. A condensate pan shall be located under the coil.
   6. A condensate pump with a 23-5/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
   7. A thermistor will be located on the liquid and gas line.

I. Electrical:
   1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

J. Control:
   1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
   2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
   3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

K. Optional Accessories Available:
   1. Remote “in-room” sensor kit KRCS01-1B (recommended).
      i. The Daikin wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

END OF SECTION
PART 1  GENERAL

1.1. VARIABLE REFRIGERANT VOLUME (VRV IV) AIR CONDITIONING-MODEL DATA:
Three Pipe Heat Recovery

A. Multiple Evaporator, Direct Expansion (DX), Air-Cooled, Variable Capacity, Split System

B. Size Range: 6 to 38 tons nominal

C. Daikin Model Number:
   1. REYQ96TYDN
   2. REYQ168TYDN

1.2. SYSTEM DESCRIPTION

A. The variable capacity, heat recovery air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat and cool model) split system as specified. The system shall consist of multiple evaporators, branch selector boxes, REFNET™ joints and headers, a three pipe refrigeration distribution system using PID control and Daikin VRV® condenser unit. The condenser shall be a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant. The condensing unit may connect an indoor evaporator capacity up to 200% of the condensing unit capacity. All zones are each capable of operating separately with individual temperature control. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance. Two-pipe, heat recovery systems utilizing a lower temperature mixed liquid/gas refrigerant to perform heat recovery are not acceptable due to reduced heating capabilities.

B. The Daikin condensing unit shall be interconnected to indoor unit models FXFQ, FXHQ, FXMLQ, FXNLQ, FXTQ, FXDQ, FXZQ, FXAQ, FXMLQ MF and FXUQ and shall range in capacity from 7,500 Btu/h to 96,000 Btu/h in accordance with Daikin’s engineering data book detailing each available indoor unit. The indoor units shall be connected to the condensing unit utilizing Daikin’s REFNET™ specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable for a variable refrigerant system.

C. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch of the cool/heat selector box (BSQ_T / BS_Q54T). Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.

D. Branch selector boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control up to 290 MBH (cooling) downstream of the branch selector box. Each branch of the branch selector box shall consist of three electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units. The branch selector box shall control the operational mode of the subordinate indoor units. The use of three EEV’s ensures continuous heating during defrost (multiple condenser systems), no heating impact during changeover and reduced sound levels. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.
E. The REYQ_T condensing unit model numbers and the associated number of connectable indoor units per REYQ_T condensing unit is indicated in the following table. Each indoor unit or group of indoor units shall be independently controlled.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Nominal Capacity (Tons)</th>
<th>Number of Connectable Indoor Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>REYQ168TYDN</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>REYQ192TYDN</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>REYQ216TYDN</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td>REYQ240TYDN</td>
<td>20</td>
<td>41</td>
</tr>
<tr>
<td>REYQ264TYDN</td>
<td>22</td>
<td>45</td>
</tr>
<tr>
<td>REYQ288TYDN</td>
<td>24</td>
<td>49</td>
</tr>
<tr>
<td>REYQ312TYDN</td>
<td>26</td>
<td>54</td>
</tr>
<tr>
<td>REYQ336TYDN</td>
<td>28</td>
<td>58</td>
</tr>
<tr>
<td>REYQ360TYDN</td>
<td>30</td>
<td>64</td>
</tr>
<tr>
<td>REYQ384TYDN</td>
<td>32</td>
<td>64</td>
</tr>
<tr>
<td>REYQ408TYDN</td>
<td>34</td>
<td>64</td>
</tr>
<tr>
<td>REYQ432TYDN</td>
<td>36</td>
<td>64</td>
</tr>
<tr>
<td>REYQ456TYDN</td>
<td>38</td>
<td>64</td>
</tr>
</tbody>
</table>

1.3. VRV IV FEATURES AND BENEFITS

A. Voltage Platform – Heat recovery condensing units shall be available with a 460V/3/60 power supply.

B. Advanced Zoning – A single system shall provide for up to 64 zones.

C. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve with 2000 positions for independent control.

D. VFD Inverter Control and Variable Refrigerant Temperature – Each condensing unit shall use high efficiency, variable speed all “inverter” compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.

E. Indoor units shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.

F. Configurator software – Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes. If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.

G. Autocharging – Each system shall have a refrigerant auto-charging function.
H. Defrost Heating – Multiple condenser VRV systems shall maintain continuous heating during defrost operation. Reverse cycle (cooling mode) defrost operation shall not be permitted due to the potential reduction in space temperature.

I. Oil Return Heating – Multiple condenser VRV systems shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.

J. Low Ambient Cooling – Each system shall be capable of low ambient cooling operation to -4°F DB.

K. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve for independent control.

L. Flexible Design –
   1. Systems shall be capable of up to 540ft (623ft equivalent) of linear piping between the condensing unit and furthest located indoor unit.
   2. Systems shall be capable of up to 3,280ft total “one-way” piping in the piping network.
   3. Systems shall have a vertical (height) separation of up to 295ft between the condensing unit and the indoor units.
   4. Systems shall be capable of up to 295ft from the first REFNET™/branch point.
   5. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit capacity.
   6. Systems shall be capable of 98ft vertical separation between indoor units.
   7. Condensing units shall be supported with a fan motor ESP up to 0.32”. WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.

M. Oil Return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle

N. Simple Wiring – Systems shall use 16/18 AWG, 2 wire, multi-stranded, non-shielded and non-polarized daisy chain control wiring.

O. Outside Air – Systems shall provide outside air capability.

P. Space Saving – Each system shall have a condensing unit module footprint as small as 36-5/8” x 30-1/8”.

Q. Advanced Diagnostics – Systems shall include a self diagnostic, auto-check function to detect a malfunction and display the type and location.

R. Each condensing unit shall incorporate contacts for electrical demand shedding with optional 3 stage demand control with 12 customizable demand settings.

S. Advanced Controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.

T. Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.
U. Low Sound Levels – Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).

1.4. QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC).

C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

D. Mechanical equipment for wind-born debris regions shall be designed in accordance with ASCE 7-2010 and installed to resist the wind pressures on the equipment and the supports.

E. The condensing unit will be factory charged with R-410A.

1.5. DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

PART 2 WARRANTY

2.1. STANDARD LIMITED WARRANTY

A. Daikin North America LLC warrants original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the “Products”) will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the “installation date” which is one of the two dates below:

1. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit’s rating plate.

2. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

B. Complete warranty details available from your local Daikin representative or at www.daikincomfort.com –

PART 3 PERFORMANCE

3.1. The VRV IV REYQ_T system shall perform as indicated below:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>System IEER* (part load - ducted)</th>
<th>System IEER* (part load – non-ducted)</th>
<th>System IEER* (part load - mixed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>20.80</td>
<td>26.20</td>
<td>23.50</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>21.00</td>
<td>29.30</td>
<td>25.15</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>20.70</td>
<td>25.40</td>
<td>23.05</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>20.70</td>
<td>24.20</td>
<td>22.45</td>
</tr>
<tr>
<td>REYQ168TYDN</td>
<td>19.50</td>
<td>22.00</td>
<td>20.75</td>
</tr>
<tr>
<td>REYQ192TYDN</td>
<td>20.40</td>
<td>22.90</td>
<td>21.65</td>
</tr>
<tr>
<td>REYQ216TYDN</td>
<td>20.20</td>
<td>22.90</td>
<td>21.55</td>
</tr>
<tr>
<td>REYQ240TYDN</td>
<td>19.20</td>
<td>21.90</td>
<td>20.55</td>
</tr>
<tr>
<td>REYQ264TYDN</td>
<td>18.10</td>
<td>21.60</td>
<td>19.85</td>
</tr>
<tr>
<td>REYQ288TYDN</td>
<td>18.20</td>
<td>21.40</td>
<td>19.80</td>
</tr>
<tr>
<td>REYQ312TYDN</td>
<td>17.80</td>
<td>20.20</td>
<td>19.00</td>
</tr>
<tr>
<td>REYQ336TYDN</td>
<td>17.00</td>
<td>19.00</td>
<td>18.00</td>
</tr>
<tr>
<td>REYQ360TYDN</td>
<td>17.90</td>
<td>19.60</td>
<td>18.75</td>
</tr>
<tr>
<td>REYQ384TYDN</td>
<td>16.60</td>
<td>18.30</td>
<td>17.45</td>
</tr>
<tr>
<td>REYQ408TYDN</td>
<td>16.50</td>
<td>17.20</td>
<td>16.85</td>
</tr>
<tr>
<td>REYQ432TYDN</td>
<td>16.50</td>
<td>16.20</td>
<td>16.35</td>
</tr>
<tr>
<td>REYQ456TYDN</td>
<td>15.90</td>
<td>16.20</td>
<td>16.05</td>
</tr>
</tbody>
</table>

<p>| Model Number | System SCHE* (part load - ducted) | System SCHE* (part load - non-ducted) | System SCHE* (part load - mixed) |
| REYQ72TYDN   | 22.60                | 27.80                | 25.20                |
| REYQ96TYDN   | 23.00                | 27.30                | 25.15                |
| REYQ120TYDN  | 25.10                | 27.90                | 26.50                |
| REYQ144TYDN  | 23.80                | 25.50                | 24.65                |
| REYQ168TYDN  | 22.80                | 26.60                | 24.70                |
| REYQ192TYDN  | 22.90                | 26.60                | 24.75                |
| REYQ216TYDN  | 22.50                | 25.60                | 24.05                |
| REYQ240TYDN  | 22.70                | 25.60                | 24.15                |
| REYQ264TYDN  | 22.00                | 24.40                | 23.20                |
| REYQ288TYDN  | 21.40                | 23.30                | 22.35                |
| REYQ312TYDN  | 20.30                | 23.60                | 21.95                |
| REYQ336TYDN  | 20.40                | 23.20                | 21.80                |
| REYQ360TYDN  | 20.20                | 22.60                | 21.40                |
| REYQ384TYDN  | 18.70                | 22.40                | 20.55                |
| REYQ408TYDN  | 18.30                | 21.80                | 20.05                |
| REYQ432TYDN  | 18.10                | 21.10                | 19.60                |
| REYQ456TYDN  | 17.90                | 20.90                | 19.40                |</p>
<table>
<thead>
<tr>
<th>Model Number</th>
<th>System EER* (full load - ducted)</th>
<th>System EER* (full load – non-ducted)</th>
<th>System EER* (full load - mixed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>13.40</td>
<td>15.80</td>
<td>14.60</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>13.10</td>
<td>15.10</td>
<td>14.10</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>12.60</td>
<td>13.90</td>
<td>13.25</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>11.90</td>
<td>12.90</td>
<td>12.40</td>
</tr>
<tr>
<td>REYQ168TYDN</td>
<td>11.30</td>
<td>11.70</td>
<td>11.50</td>
</tr>
<tr>
<td>REYQ192TYDN</td>
<td>12.60</td>
<td>12.50</td>
<td>12.55</td>
</tr>
<tr>
<td>REYQ216TYDN</td>
<td>12.40</td>
<td>12.50</td>
<td>12.45</td>
</tr>
<tr>
<td>REYQ240TYDN</td>
<td>11.60</td>
<td>12.20</td>
<td>11.90</td>
</tr>
<tr>
<td>REYQ264TYDN</td>
<td>10.50</td>
<td>11.80</td>
<td>11.15</td>
</tr>
<tr>
<td>REYQ288TYDN</td>
<td>10.90</td>
<td>11.80</td>
<td>11.35</td>
</tr>
<tr>
<td>REYQ312TYDN</td>
<td>10.60</td>
<td>11.30</td>
<td>10.95</td>
</tr>
<tr>
<td>REYQ336TYDN</td>
<td>10.00</td>
<td>10.70</td>
<td>10.35</td>
</tr>
<tr>
<td>REYQ360TYDN</td>
<td>11.00</td>
<td>10.80</td>
<td>10.90</td>
</tr>
<tr>
<td>REYQ384TYDN</td>
<td>9.80</td>
<td>9.80</td>
<td>9.80</td>
</tr>
<tr>
<td>REYQ408TYDN</td>
<td>9.70</td>
<td>9.80</td>
<td>9.75</td>
</tr>
<tr>
<td>REYQ432TYDN</td>
<td>9.70</td>
<td>9.80</td>
<td>9.75</td>
</tr>
<tr>
<td>REYQ456TYDN</td>
<td>9.50</td>
<td>9.50</td>
<td>9.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model Number</th>
<th>System COP@47F* (full load - ducted)</th>
<th>System COP@47F* (full load – non-ducted)</th>
<th>System COP@47F* (full load - mixed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>3.82</td>
<td>4.29</td>
<td>4.06</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>3.72</td>
<td>4.25</td>
<td>3.99</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>3.51</td>
<td>3.98</td>
<td>3.75</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>3.55</td>
<td>3.81</td>
<td>3.68</td>
</tr>
<tr>
<td>REYQ168TYDN</td>
<td>3.33</td>
<td>3.77</td>
<td>3.55</td>
</tr>
<tr>
<td>REYQ192TYDN</td>
<td>3.67</td>
<td>3.84</td>
<td>3.76</td>
</tr>
<tr>
<td>REYQ216TYDN</td>
<td>3.67</td>
<td>3.73</td>
<td>3.70</td>
</tr>
<tr>
<td>REYQ240TYDN</td>
<td>3.55</td>
<td>3.67</td>
<td>3.61</td>
</tr>
<tr>
<td>REYQ264TYDN</td>
<td>3.38</td>
<td>3.55</td>
<td>3.47</td>
</tr>
<tr>
<td>REYQ288TYDN</td>
<td>3.26</td>
<td>3.51</td>
<td>3.39</td>
</tr>
<tr>
<td>REYQ312TYDN</td>
<td>3.22</td>
<td>3.56</td>
<td>3.39</td>
</tr>
<tr>
<td>REYQ336TYDN</td>
<td>3.20</td>
<td>3.52</td>
<td>3.36</td>
</tr>
<tr>
<td>REYQ360TYDN</td>
<td>3.31</td>
<td>3.51</td>
<td>3.41</td>
</tr>
<tr>
<td>REYQ384TYDN</td>
<td>3.21</td>
<td>3.21</td>
<td>3.21</td>
</tr>
<tr>
<td>REYQ408TYDN</td>
<td>3.20</td>
<td>3.21</td>
<td>3.21</td>
</tr>
<tr>
<td>REYQ432TYDN</td>
<td>3.20</td>
<td>3.21</td>
<td>3.21</td>
</tr>
<tr>
<td>REYQ456TYDN</td>
<td>3.20</td>
<td>3.21</td>
<td>3.21</td>
</tr>
</tbody>
</table>
A. Performance Conditions
   1. Cooling: indoor temp. of 80°F DB, 67°F WB and outdoor temp. of 95°F DB.
   2. Heating: indoor temp. of 70°F DB and outdoor temp. of 47°F DB, 43°F WB.
   3. Equivalent piping length: 25ft

3.2. OPERATING RANGE

A. The operating range in cooling or cooling dominant simultaneous cooling/heating will be (-4°F) 23°F DB ~ 122°F DB.

B. Each system as standard shall be capable of onsite reprogramming to allow low ambient cooling operation down to -4°F DB

C. The operating range in heating or heating dominant simultaneous cooling/heating will be -13°F WB – 60°F WB.

D. If an alternate equipment manufacturer is selected, the mechanical contractor shall provide, at their own risk and cost, all additional material and labor to meet low ambient operating condition and performance.

E. Cooling mode indoor room temperature range will be 57°F-77°F WB.

F. Heating mode indoor room temperature range will be 59°F-80°F DB.

3.3. REFRIGERANT PIPING

A. The system shall be capable of refrigerant piping up to 540 actual feet or 623 equivalent feet from the condensing unit to the furthest indoor unit, a total combined liquid line

<table>
<thead>
<tr>
<th>Model Number</th>
<th>System COP@17F* (full load - ducted)</th>
<th>System COP@17F* (full load – non-ducted)</th>
<th>System COP@17F* (full load - mixed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>2.63</td>
<td>2.77</td>
<td>2.70</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>2.31</td>
<td>2.63</td>
<td>2.47</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>2.32</td>
<td>2.54</td>
<td>2.43</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>2.35</td>
<td>2.56</td>
<td>2.46</td>
</tr>
<tr>
<td>REYQ168TYDN</td>
<td>2.15</td>
<td>2.32</td>
<td>2.24</td>
</tr>
<tr>
<td>REYQ192TYDN</td>
<td>2.38</td>
<td>2.55</td>
<td>2.47</td>
</tr>
<tr>
<td>REYQ216TYDN</td>
<td>2.28</td>
<td>2.45</td>
<td>2.37</td>
</tr>
<tr>
<td>REYQ240TYDN</td>
<td>2.31</td>
<td>2.48</td>
<td>2.40</td>
</tr>
<tr>
<td>REYQ264TYDN</td>
<td>2.26</td>
<td>2.42</td>
<td>2.34</td>
</tr>
<tr>
<td>REYQ288TYDN</td>
<td>2.24</td>
<td>2.41</td>
<td>2.33</td>
</tr>
<tr>
<td>REYQ312TYDN</td>
<td>2.24</td>
<td>2.41</td>
<td>2.33</td>
</tr>
<tr>
<td>REYQ336TYDN</td>
<td>2.06</td>
<td>2.18</td>
<td>2.12</td>
</tr>
<tr>
<td>REYQ360TYDN</td>
<td>2.17</td>
<td>2.42</td>
<td>2.30</td>
</tr>
<tr>
<td>REYQ384TYDN</td>
<td>2.06</td>
<td>2.34</td>
<td>2.20</td>
</tr>
<tr>
<td>REYQ408TYDN</td>
<td>2.06</td>
<td>2.09</td>
<td>2.08</td>
</tr>
<tr>
<td>REYQ432TYDN</td>
<td>2.06</td>
<td>2.08</td>
<td>2.07</td>
</tr>
<tr>
<td>REYQ456TYDN</td>
<td>2.05</td>
<td>2.07</td>
<td>2.06</td>
</tr>
</tbody>
</table>
length of 3,280 feet of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps.

B. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

3.4. DESIGN BASIS

A. The HVAC equipment basis of design is Daikin North America. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

PART 4 PRODUCTS

4.1. CONDENSING UNIT

A. General: The condensing unit is designed specifically for use with VRV IV series components.

1. The condensing unit shall be factory assembled in the USA and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator.

High/low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.

2. The condensing unit can be wired and piped with access from the left, right, rear or bottom.

3. The connection ratio of indoor units to condensing unit shall be permitted up to 200%.

4. Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.

5. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.

6. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

7. The unit shall incorporate an auto-charging feature. Manual changing should be support with a minimum of 2 hours of system operation data to ensure correct operation.
8. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

9. The following safety devices shall be included on the condensing unit: high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

10. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.

11. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation.

12. The condensing unit shall be capable of heating operation at -13°F wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.

13. The multiple condenser VRV systems shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

B. Unit Cabinet:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:

1. The condensing unit shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Fan Motor Output (kW) &amp; Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>0.50</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>0.60 x 2</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>0.60 x 2</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>0.60 x 2</td>
</tr>
<tr>
<td>REYQ168TYDN</td>
<td>0.60 x 2</td>
</tr>
<tr>
<td>REYQ192TYDN</td>
<td>(0.50 x 1) + (0.60 x 2)</td>
</tr>
<tr>
<td>REYQ216TYDN</td>
<td>(0.60 x 2) x 2</td>
</tr>
<tr>
<td>REYQ240TYDN</td>
<td>(0.60 x 2) x 2</td>
</tr>
<tr>
<td>REYQ264TYDN</td>
<td>(0.60 x 2) x 2</td>
</tr>
<tr>
<td>REYQ288TYDN</td>
<td>(0.60 x 2) x 2</td>
</tr>
<tr>
<td>REYQ312TYDN</td>
<td>(0.60 x 2) x 2</td>
</tr>
<tr>
<td>REYQ336TYDN</td>
<td>(0.60 x 2) x 2</td>
</tr>
<tr>
<td>REYQ360TYDN</td>
<td>(0.60 x 2) x 3</td>
</tr>
<tr>
<td>REYQ384TYDN</td>
<td>(0.60 x 2) x 3</td>
</tr>
<tr>
<td>REYQ408TYDN</td>
<td>(0.60 x 2) x 3</td>
</tr>
<tr>
<td>REYQ432TYDN</td>
<td>(0.60 x 2) x 3</td>
</tr>
<tr>
<td>REYQ456TYDN</td>
<td>(0.60 x 2) x 3</td>
</tr>
</tbody>
</table>
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.

3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 5,544 CFM to 24,684 CFM dependent on model specified.

4. Nominal sound pressure levels shall be as shown below.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Sound Pressure Level dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>58</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>61</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>61</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>65</td>
</tr>
<tr>
<td>REYQ168TYDN</td>
<td>65</td>
</tr>
<tr>
<td>REYQ192TYDN</td>
<td>63</td>
</tr>
<tr>
<td>REYQ216TYDN</td>
<td>64</td>
</tr>
<tr>
<td>REYQ240TYDN</td>
<td>66</td>
</tr>
<tr>
<td>REYQ264TYDN</td>
<td>66</td>
</tr>
<tr>
<td>REYQ288TYDN</td>
<td>68</td>
</tr>
<tr>
<td>REYQ312TYDN</td>
<td>68</td>
</tr>
<tr>
<td>REYQ336TYDN</td>
<td>68</td>
</tr>
<tr>
<td>REYQ360TYDN</td>
<td>66</td>
</tr>
<tr>
<td>REYQ384TYDN</td>
<td>68</td>
</tr>
<tr>
<td>REYQ408TYDN</td>
<td>69</td>
</tr>
<tr>
<td>REYQ432TYDN</td>
<td>70</td>
</tr>
<tr>
<td>REYQ456TYDN</td>
<td>70</td>
</tr>
</tbody>
</table>

5. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.

6. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

7. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

<table>
<thead>
<tr>
<th>Operation Sound dB(A)</th>
<th>Night Mode Sound Pressure Level dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 max.</td>
<td>55</td>
</tr>
<tr>
<td>Step 2 max.</td>
<td>50</td>
</tr>
<tr>
<td>Step 3 max.</td>
<td>45</td>
</tr>
</tbody>
</table>

D. Condenser Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.

4. The fins are to be covered with an anti-corrosion Ulta Gold coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test: 500hr (ASTM G85 & Blister Rating:10)

5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

6. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for bottom plate heater. The lower part of the coil shall be used for inverter cooling and be on or off during heating operation enhancing the defrost operation.

7. The condensing unit shall be factory equipped with condenser coil guards on all sides.

E. Compressor:

1. The Daikin inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value. Non inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.

2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” or “J-type”.

3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

4. The capacity control range shall be as low as 3% to 100%.

5. The compressors’ motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.

6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration eliminating the standard need for spring insolation.

9. Compressor configurations

<table>
<thead>
<tr>
<th>Tonnage</th>
<th>Number of Compressors</th>
<th>Compressor Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1</td>
<td>Inverter controlled</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>26</td>
<td>4</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>28</td>
<td>4</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>32</td>
<td>6</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>34</td>
<td>6</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>36</td>
<td>6</td>
<td>All inverter controlled</td>
</tr>
<tr>
<td>38</td>
<td>6</td>
<td>All inverter controlled</td>
</tr>
</tbody>
</table>

14. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

15. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours and extending the operating life of the system. When connected to a central control system, sequential start is activated for all system on each DIII network.

F. Electrical:

1. The power supply to the condensing unit shall be 460 volts, 3 phase, 60 hertz +/- 10%.

<table>
<thead>
<tr>
<th>Power Supply Voltage</th>
<th>Voltage Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>460V/3/60</td>
<td>416V-508V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>MCA</th>
<th>MOP</th>
<th>Compressor RLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>REYQ72TYDN</td>
<td>15.2</td>
<td>20</td>
<td>9.4</td>
</tr>
<tr>
<td>REYQ96TYDN</td>
<td>21.1</td>
<td>25</td>
<td>6.2 + 6.2</td>
</tr>
<tr>
<td>REYQ120TYDN</td>
<td>21.1</td>
<td>25</td>
<td>6.8 + 6.8</td>
</tr>
<tr>
<td>REYQ144TYDN</td>
<td>31.9</td>
<td>40</td>
<td>7.3 + 10.3</td>
</tr>
</tbody>
</table>
Haikey Creek Operation & Maintenance  
Capital Equipment Replacements  
RMUA Project No. WPC 20-2  

REYQ168TYDN 36.1 40 7.9 + 11.1  
REYQ192TYDN 15.2 + 21.1 20 + 25 9.4 + (6.8 + 6.8)  
REYQ216TYDN 21.1 + 21.1 25 + 25 (6.2 + 6.2) + (6.8 + 6.8)  
REYQ240TYDN 21.1 + 31.9 25 + 40 (6.2 + 6.2) + (7.3 + 10.3)  
REYQ264TYDN 21.1 + 31.9 25 + 40 (6.8 + 6.8) + (7.3 + 10.3)  
REYQ288TYDN 31.9 + 31.9 40 + 40 (7.3 + 10.3) + (7.9 + 11.1)  
REYQ312TYDN 31.9 + 36.1 40 + 40 (7.3 + 10.3) + (7.9 + 11.1)  
REYQ336TYDN 36.1 + 36.1 40 + 40 (7.9 + 11.1) x 2  
REYQ360TTJU 21.1 + 21.1 + 21.1 25 + 25 + 25 (6.8 + 6.8) x 3  
REYQ384TTJU 21.1 + 21.1 + 31.9 25 + 25 + 40 (6.2 + 6.2) + (6.8 + 6.8) + (7.9 + 11.1)  
REYQ408TTJU 21.1 + 31.9 + 36.1 25 + 40 + 40 (6.2 + 6.2) + (7.3 + 10.3) + (7.9 + 11.1)  
REYQ432TTJU 31.9 + 31.9 + 31.9 40 + 40 + 40 (7.3 + 10.3) x 3  
REYQ456TTJU 31.9 + 31.9 + 36.1 40 + 40 + 40 (7.3 + 10.3) x 2 + (7.9 + 11.1)  
REYQ480TTJU 36.1 + 36.1 + 36.1 40 + 40 + 40 (7.9 + 11.1) x 3  
REYQ504TTJU 36.1 + 36.1 + 36.1 40 + 40 + 40 (7.9 + 11.1) x 4  
REYQ528TTJU 36.1 + 36.1 + 36.1 40 + 40 + 40 (7.9 + 11.1) x 5  
REYQ552TTJU 36.1 + 36.1 + 36.1 40 + 40 + 40 (7.9 + 11.1) x 6  
REYQ576TTJU 36.1 + 36.1 + 36.1 40 + 40 + 40 (7.9 + 11.1) x 7  
REYQ600TTJU 36.1 + 36.1 + 36.1 40 + 40 + 40 (7.9 + 11.1) x 8  

2. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.

3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.

4. The control wiring lengths shall be as shown below.

<table>
<thead>
<tr>
<th>Control Wiring Length</th>
<th>Condenser to Indoor Unit</th>
<th>Condenser to Central Controller</th>
<th>Indoor Unit to Remote Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,665 ft</td>
<td>3,330 ft</td>
<td>1,665 ft</td>
<td></td>
</tr>
</tbody>
</table>

Wire Type 16/18 AWG, 2 wire, non-polarity, non-shielded, stranded

4.2. BS(4/6/8/10/12)Q_T BRANCH SELECTOR BOX FOR VRV IV HEAT RECOVERY SYSTEM

A. General: The BSQ36TVJ, BSQ60TVJ, BSQ96TVJ, BSQ454TVJ, BS60Q54TVJ, BS8Q54TVJ, BS10Q54TVJ and BS12Q54TVJ branch selector boxes are designed specifically for use with VRV IV series heat recovery system components.

1. These selector boxes shall be factory assembled, wired, and piped.

2. These BSQ_T / BS(4/6/8/10/12)Q54T branch controllers must be run tested at the factory.

3. These selector boxes must be mounted indoors.

4. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

5. The number of connectable indoor units shall be in accordance with the table below:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Connectable Cooling Capacity</th>
<th>Maximum Number of Connectable Indoor Units Per Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSQ36TVJ</td>
<td>36,000 Btu/h</td>
<td>4</td>
</tr>
<tr>
<td>BSQ60TVJ</td>
<td>60,000 Btu/h</td>
<td>8</td>
</tr>
<tr>
<td>BSQ96TVJ</td>
<td>96,000 Btu/h</td>
<td>8</td>
</tr>
</tbody>
</table>
B. Unit Cabinet:

1. These units shall have a galvanized steel plate casing.

2. Each cabinet shall house 3 electronic expansion valves for refrigerant control per branch.

3. The cabinet shall contain one subcooling heat exchanger per branch.

4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

5. Nominal sound pressure levels must be measured and published on the submittals by the manufacturer. These sound levels must not exceed the values below.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Sound Level dB(A) Operating</th>
<th>Sound Level dB(A) Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSQ36TVJ</td>
<td>42</td>
<td>32</td>
</tr>
<tr>
<td>BSQ60TVJ</td>
<td>43</td>
<td>32</td>
</tr>
<tr>
<td>BSQ96TVJ</td>
<td>44</td>
<td>34</td>
</tr>
<tr>
<td>BS4Q54TVJ</td>
<td>38</td>
<td>45</td>
</tr>
<tr>
<td>BS6Q54TVJ</td>
<td>39</td>
<td>47</td>
</tr>
<tr>
<td>BS8Q54TVJ</td>
<td>39</td>
<td>47</td>
</tr>
<tr>
<td>BS10Q54TVJ</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>BS12Q54TVJ</td>
<td>40</td>
<td>48</td>
</tr>
</tbody>
</table>

6. If an alternate manufacturer is selected, the mechanical contractor shall provide, at their own cost and expense, any additional material and labor to meet the published sound levels above.

C. Dimensions:

1. Each BSQ_T unit shall be no larger than 8-1/8" x 15-1/4" x 12-13/16".

2. Each BS4Q_T shall be no larger than 11-3/4" x 14-9/16" x 18-15/16".

3. Each BS(6/8)Q_T shall be no larger than 11-3/4" x 22-13/16" x 18-15/16".

4. Each BS(10/12)Q_T shall be no larger than 11-3/4" x 32-5/16" x 18-15/16".

D. Refrigerant Valves:
1. The unit shall be furnished with 3 electronic expansion valves per branch to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.

2. The refrigerant connections must be of the braze type.

3. In multi-port units, each port shall have its own electronic expansion valves. If common expansion/solenoid valves are used, redundancy must be provided.

4. Each circuit shall have at least one (36,000 Btu/h indoor unit or smaller for the BSQ36TVJ, 54,000 Btu/h indoor unit or smaller for the BS(4/6/8/10/12)Q54TVJ, 60,000 Btu/h indoor unit or smaller for the BSQ60TVJ and 96,000 Btu/h indoor unit or smaller for the BSQ96TVJ) branch selector box.

5. Multiple indoor units may be connected to a branch selector box with the use of a REFINET™ joint provided they are within the capacity range of the branch selector.

E. Condensate Removal:
   1. The unit shall not require provisions for condensate removal. A safety device or secondary drain pan shall be installed by the mechanical contractor to comply with the applicable mechanical code, if an alternate manufacturer is selected.

F. Electrical:
   1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
   2. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
   3. The minimum circuit amps (MCA) shall be 0.1 and the maximum overcurrent protection amps (MOP) shall be 15.
   4. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

END OF SECTION
PART 1  General

1.1.  Physical characteristics

A.  General:
B.  The advanced multi-zone controller shall be made from plastic materials with a neutral color. Each control shall have a LCD (Liquid Crystal Display) that shows On/Off, setpoint, room temperature, mode of operation (Cool/Heat/Dry/Fan/Auto), louver position, and fan speed.

1.2.  1.02.  Electrical characteristics

A.  General: The advanced multi-zone controller will require 24 VAC to power the controller. The advanced multi-zone controller shall supply 16 VDC to the communication bus on the F1F2 (out-out) terminal of the outdoor unit. The voltage may rise or fall in relation to the transmission packets that are sent and received.
B.  Wiring: The advanced multi-zone controller communication wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to branch selector (Heat Recovery system), then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote control wiring shall run from the indoor unit control terminal block to the remote controller connected with that indoor unit.
C.  Wiring size: Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, and 18 AWG stranded copper wire.

1.3.  VRV Controls Network

The VRV Controls Network is made up of local remote controllers, multi-zone controllers, advanced multi-zone controllers, and open protocol network devices that transmit information via the communication bus. The VRV Controls Network shall also have the ability to be accessed via a networked PC. The VRV Controls Network supports operation monitoring, scheduling, error e-mail distribution, general user software, tenant billing, maintenance support, and integration with Building Management Systems (BMS) using open protocol via BACnet® interface, Lonworks® interface or Modbus® adapter; all of which blend to provide the optimal control strategy for the best HVAC comfort solution.

PART 2  PRODUCTS

2.1.  Advanced Multi-zone Controllers

A.  The Daikin AC VRV advanced multi-zone controllers are compatible with all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. The advanced multi-zone controller wiring consist of a non-polar two-wire connection to the outdoor unit. The advanced multi-zone controllers may be wall-mounted and can be adjusted to maintain the optimal operation of up to 64 connected indoor unit groups and 128 indoor units. Set temperatures can be adjusted in increments of 1°F. In the cases where a system or unit error may occur, the VRV controllers will display a two-digit error code and the unit address.

2.2.  DCM601A71: intelligent Touch Manager (iTM)  V2.XX.XX
A. The intelligent Touch Manager (version 2.04) shall provide control for all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. It shall be capable of controlling a maximum or 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The intelligent Touch Manager shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.

B. The controller wiring shall consist of a non-polar two-wire connection to the indoor unit at terminals F1F2 (out-out) of the outdoor unit. The intelligent Touch Manager is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s).

C. The intelligent Touch Manager can be used in conjunction with the BRC1E73 (Navigation Remote Controller), the BRC2A71 (Simplified Remote Controller), or the BRC4C82/7E83/7C812/7E818 (Wireless Remote Controller), BACnet interface, Lonworks interface, and Modbus adapter to control the same indoor unit groups. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each remote controller group associated with the intelligent Touch Manager. DIII-NET address can be set for one (1) indoor unit or each indoor unit in the remote controller group. No more than 2 remote controllers can be placed in the same group.

D. The intelligent Touch Manager shall be equipped with two RJ-45 Ethernet ports for 100 Mbps network communication to support interconnection with a network PC via the Internet, Local Area Network (LAN), or connection with a non-networked PC after completed installation.

E. Web access functions shall be available so that facility staff can securely log into each Intelligent Touch Manager via the PC’s web browser to support monitoring, scheduling, error recognition, and general user functions. Error emails are also sent to designated email addresses. An additional optional software function Power Proportional Distribution (PPD) tenant billing shall also be available. The optional software shall require advanced purchase and can only be activated upon receipt of a license activation key from Daikin AC.

1. Mounting:
   The intelligent Touch Manager shall be mounted on the wall or into the mounting fixtures included with the intelligent Touch Manager.

2. Display Features:
   a. The intelligent Touch Manager shall be approximately 11.42" x 9.57" x 1.97" in size with a backlit 10.4" LCD display.
   b. Display information shall be selectable from English, French, Italian, Korean, Dutch, Portuguese, Chinese, Japanese, German, or Spanish.
   c. Featured backlit LCD with auto off after 30 minutes (default) is adjustable between 1 to 60 minutes, or the choice of 3 different screen savers.
   d. Area and Group configuration
      1) Area contains one (1) or more Area(s) or Group(s)
      2) A Group may be an indoor unit, Di, Dio point that has a DIII-Net address
      3) A Group may be an external management point such as a Di, Do, Bi, Bo, Bv, Ai, Ao, Av, Mi, Mo, Mv that does not have a DIII-Net address
   e. An Area is a tiered group where management points (indoor unit, digital input/output, and analog input/output groups) can be monitored and controlled by global settings. Up to 650 Areas can be created. Area hierarchy can have up to 10 tiered levels (ex. top level: 1st floor West, 2nd level: offices, hallways, 3rd level: Office
101, 102, and 103, etc.). Area configuration shall classify levels of monitoring and control for each management point
1) Areas and Groups may be assigned names (ex. Office 101, Lobby, North Hallway, etc.)

f. The Controller shall display On/Off, Operation Mode, Setpoint, Space Temperature, Louver Position, Fan Speed for each Area or Group.
g. The Controller shall display Date (mm/dd/yyyy, yyyy/mm/dd, or dd/mm/yyyy format selectable) and day of the week along with the time of day (12hr or 24hr display selectable).
h. The Controller shall adjust for daylight savings time (DST) automatically.
i. Display information shall be updated every 3 seconds to show the latest status of the indoor unit groups.
j. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Setback, Filter, Maintenance, and Screen Lock.
k. The controller shall display the temperature setpoint in one degree increments with a range of 60°F – 90°F, 1°F basis (16°C – 32°C, 0.1°C basis). 
   1) Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius
l. Display shall reflect room temperature in one tenth degree increments with a range of-58°F – 248°F, 0.1°F basis (-50°C – 120°C, 0.1°C basis) with 0.1°C accuracy.
   1) Display of room temperature information shall be configurable for Fahrenheit or Celsius
m. The Menu List shall be used to configure options and display information for each Area or Group.
n. Error status shall be displayed in the event of system abnormality/error with one of three color coded icons placed over the indoor unit icon or lower task bar.
   1) System errors are generated when the intelligent Touch Manager system with other VRV controls systems are combined incorrectly or power proportional distribution calculation errors occur. The intelligent Touch Manager shall display the error with a red triangle placed on the lower task bar.
   2) Unit errors occurring within the VRV system shall be displayed with a yellow triangle placed over the indoor unit icon
   3) Limit errors are based upon preconfigured analog input upper and lower limit settings and are generated when the limits have been met. When limit error is generated a yellow triangle will be placed over the unit icon.
   4) Communication errors between the intelligent Touch Manager and the indoor units shall be displayed with a blue triangle placed over the indoor unit icon
   5) Error history shall be available for viewing for up to 500,000 errors/abnormality events with operation events.

o. Layout View
   1) Capable of displaying site floor plan or graphical user interface (GUI) as the background for visual navigation. Indoor unit, DIII-Net Di and Dio, and External Di, Do, Ai, Ao, Av, Mi, Mo, Mv icons with operational status can be placed on the floor layout or GUI
      i) Up to 4 status points can be assigned to the indoor unit icon (room name, room temperature, setpoint, and mode)
      ii) Digital input and output icons will display On/Off status
      iii) Analog icons will display Ai, Ao and Av.
      iv) Multistate icons will display Mi, Mo and Mv.
   2) Up to 60 floor layout sections can be created

3. Basic Operation:
   a. Capable of controlling by Area(s) or Group(s)
   b. Controller shall control the following group operations:
1) On/Off
2) Operation Mode (Cool, Heat, Fan, Dry, and Auto)
3) Independent Cool and Heat dual Setpoints or single Setpoint for current mode in the occupied period
4) Controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Area or Group configurations
5) Independent Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 50 - 95°F
   i) Setup and Setback setpoints can only be set outside of the occupied setpoint range
   ii) The Setup and Setback setpoints will automatically maintain a 2°F fixed differential from the highest possible occupied setpoints
   iii) The recovery differential shall be 4°F (default) and adjustable between 2 – 10°F
   iv) Settings shall be applied based upon the Area or Group configurations
6) Fan Speed
   i) Up to 3 speeds (dependent upon indoor unit type)
7) Airflow direction (dependent upon indoor unit type)
   i) 5 fixed positions or oscillating
8) Remote controller permit/prohibit of On/Off, Mode, and Setpoint
9) Lock out setting for Intelligent Touch Manager display
10) Indoor unit Group/Area assignment

   c. Capable of providing battery backup power for the clock at least 1 year when no AC power is applied.
      1) The battery can last at least 13 years when AC power is applied
      2) Settings stored in non-volatile memory

4. Programmability:
   a. Controller shall support weekly schedule settings.
      1) 7 day weekly pattern (7)
      2) Weekday + Weekend (5 + 2)
      3) Weekday + Saturday + Sunday (5 + 1 + 1)
      4) Everyday (1)
      5) The schedule shall have the capabilities of being enabled or disabled
      6) 100 independent schedules configurable with up to 20 events settable for each days schedule
         i) Each scheduled event shall specify time and target Area or Group
         ii) Each scheduled event shall include On/Off, Optimum Start, Operation Mode, Occupied Setpoints, Setback Setpoints, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit, Timer Extension Setting, Fan Speed, and Setpoint Range Limit
            • Setpoint when unit is On (occupied)
            • Configurable Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied)
         iii) Time setting in 1-minute increments
         iv) Timer Extension shall be used for a timed override (settable from 30 – 180 minutes) to allow indoor unit operation during the unoccupied period
      7) A maximum of 40 exception days can be schedule on the yearly schedule (repeats yearly)
         i) Exception days shall be used to override specified days on the weekly schedule based upon irregular occupied/unoccupied conditions
         ii) Exception days can be configured on a set date (Jan 1) or floating date (1st Monday in September)
   b. Controller shall support auto-changeover.
1) Auto-change shall provide Fixed (default), Individual, Averaging, and Vote changeover methods for both Heat Pump and Heat Recovery systems based upon the changeover group configuration. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat in accordance with the room temperature and setpoint. The following changeover scheme shall be applicable to the Fixed, Individual, and Averaging methods.

   i) Changeover to cooling mode shall occur at cooling setpoint + 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
   • Configurable from 1 – 4°F (0.5 – 2°C)
   ii) Changeover to cooling mode shall occur at the primary changeover deadband to cooling + 1°F (0.5°C) as the secondary changeover deadband.
   • Configurable from 1 – 4°F (0.5 – 2°C)
   iii) Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
   • Configurable from 1 – 4°F (0.5 – 2°C)
   iv) Changeover to heating mode shall occur at the primary changeover deadband to heating - 1°F (0.5°C) as the secondary changeover deadband.
   • Configurable from 1 – 4°F (0.5 – 2°C)
   v) A weighted demand shall be configurable for the Averaging and Vote methods.

2) Fixed Method
   i) Changeover evaluated by room temperature and setpoint of the representative indoor unit (first registered indoor unit in changeover group) in the changeover group even when it is not operating (must be in Cool, Heat, or Auto mode)
   ii) Changeover affects all indoor unit groups in the changeover group.

3) Individual method (recommended for Heat Recovery Systems)
   i) Changeover evaluated by room temperature and setpoints of the individual indoor unit group in the changeover group
   ii) Changeover affects individual indoor unit group in the changeover group

4) Average method
   i) Changeover evaluated by the average of all indoor unit group’s room temperatures and setpoints operating in Cool, Heat, or Auto mode in the changeover group list
   ii) If none of the indoor units in the group meet the above requirements the Fixed method of changeover will be applied
   iii) A weighted demand (0 – 3) can be configured for each indoor unit in the changeover group.
   iv) Changeover affects all indoor unit groups in the changeover group.

5) Vote Method
   i) In each indoor unit, the cooling demand is calculated based upon the difference between the room temperature and cooling setpoint. If the room temperature falls below the primary cool changeover point (cool setpoint plus the primary changeover deadband) the cooling demand is considered as 0 (zero). Then the total cooling demand is calculated as the sum of each indoor unit’s cooling demand
   ii) The opposite is true for the total heating demand
   iii) A weight (0-3) can be added to each indoor unit’s demand in the changeover group. The default setting is 1
   iv) The weight 0 (zero) means the indoor unit’s demand is not added in the total demand, so the indoor unit’s demand is considered to be 0 (zero)
v) The weight 2 or 3 means the indoor unit’s demand is added 2 or 3 times in the total demand, respectively
vi) Changeover to cooling mode shall occur when the total cooling demand is greater than the total heating demand.
vii) The opposite is true for changeover to heating
viii) Vote supports a Heating Override option, which prioritizes switching to the heating mode if at least one room temperature falls below the secondary heat changeover point (heat setpoint minus the secondary changeover deadband) even if the total cooling demand is greater than the total heating demand.
ix) Changeover affects all indoor unit groups in the changeover group.

6) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained to the same outdoor unit in the Heat Pump system or branch selector box in the Heat Recovery system.

7) Guard timer
   i) Upon changeover, guard timer will prevent another changeover during the guard timer activation period (15, 30, 60 (default) min).
   ii) Guard timer is ignored by a change of setpoint manually from either intelligent Touch Manager or Remote Controller, by schedule, or the room temperature meets or exceeds the secondary changeover deadband of the mode opposite of the current mode setting.

c. Controller shall support Interlock
   1) Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc…) to automatically control Groups or Areas corresponding to the change of the operation states or the On/Off states of any Group.
   2) WAGO I/O unit – Di, Do, Ai, Ao
      i) On/Off based monitoring and control of equipment
      ii) Manual or scheduled operation of equipment
      iii) Operation based upon interlock with management points (group(s))
      iv) Monitor equipment error/alarm status
   3) Digital Input/Output (DEC102A51-US2) unit or Digital Input (DEC101A51-US2) unit
      i) On/Off based monitoring and control of equipment
      ii) Manual or scheduled operation of equipment
      iii) Operation based upon interlock with management points (group(s))
      iv) Monitor equipment error/alarm status

d. Controller shall support force shutdown of associated indoor unit groups.

5. Web/Email Function
   a. Each intelligent Touch Manager shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (up to 512 indoor unit groups with the addition of the iTM Plus Adapter) from a networked PC’s web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 10 email addresses).
   b. All PCs shall be field supplied

6. Optional Software
   Licensed per option, per intelligent Touch Manager shall be required.
   a. DCM002A71: Power Proportional Distribution (PPD)
      1) The tenant billing option shall be capable of calculating VRV Controls Network equipment energy usage in kWh based on the energy consumption of the
outdoor unit(s) divided among the associated indoor units. This software is used in conjunction with the intelligent Touch Manager and a Watt Hour Meter (WHM). A maximum of 3 Watt Hour Meters can be connected to the intelligent Touch Manager. Up to 4 additional Watt Hour Meters can be connected to each iTM Plus Adapter, and up to 7 iTM Plus Adapters can be connected to the intelligent Touch Manager.

2) The Power Proportional Distribution results data can be saved to a USB flash drive, or on a PC with the use of the web access. Data is saved in the CSV format. Results can be stored up to 13 months in the intelligent Touch Manager.

b. DCM009A51: BACnet Client Option
1) The iTM BACnet Client Option shall be capable of making the intelligent Touch Manager work as a BACnet client using the BACnet/IP protocol. A BACnet client machine is able to send service requests to a BACnet server machine that then performs the services and reports the results to the client. By registering equipment and sensors connected to a BACnet server as management points, equipment and sensors can be monitored and controlled by the intelligent Touch Manager. The BACnet Client option must be enabled/activated in each intelligent Touch Manager to be used.

2) System Capacity
   i) A maximum of 50 BACnet servers can be monitored and/or controlled by one intelligent Touch Manager.
   ii) A maximum of 1536 objects can be monitored and/or controlled by one intelligent Touch Manager.
   iii) A maximum of 512 management points, including BACnet management points, external management points, internal Ai management points, AHU management points, and Chiller management points, can be registered in one intelligent Touch Manager.

3) Objects that can be used in BACnet management points are:
   i) Analog Input (Object Type Number 0)
   ii) Analog Output (Object Type Number 1)
   iii) Analog Value (Object Type Number 2)
   iv) Binary Input (Object Type Number 3)
   v) Binary Output (Object Type Number 4)
   vi) Binary Value (Object Type Number 5)
   vii) Multi-State Input (Object Type Number 13)
   viii) Multi-State Output (Object Type Number 14)
   ix) Multi-State Value (Object Type Number 19)

c. DCM014A51: BACnet Server Gateway Option
1) The iTM BACnet Server Gateway Option shall be capable of making the intelligent Touch Manager work as a BACnet gateway using the BACnet/IP protocol. The iTM BACnet Server Gateway Option shall be capable of exposing indoor unit management points as BACnet objects to the (BMS). The iTM BACnet Server/Gateway Option shall be capable of allowing the BMS to monitor and control indoor units BACnet objects.

2) The iTM BACnet Server Gateway Option shall be compatible with VRV, SkyAir, Outdoor Air Processing Unit, Mini-Split system with use of KRP928, and FFQ indoor unit for Multi-split system.

3) Functions:
   i. The iTM BACnet Server Gateway Option shall be capable of supporting Change of Value (COV) notification.
ii. The iTM BACnet Server Gateway Option shall communicate to BMS using port number 47808 (configurable).

iii. The iTM BACnet Server Gateway Option shall function as BACnet router to provide unique virtual BACnet device identification number (ID) for every indoor unit group address.

iv. The iTM BACnet Server Gateway Option shall provide configurable BACnet Network number.

v. The iTM BACnet Server Gateway Option shall be capable of being configured as a foreign device. It shall be capable of communicating across BACnet Broadcast Management Devices (BBMD) in different subnet networks.

vi. The iTM BACnet Server Gateway Option shall be run in environments with BACnet communication traffic up to 100 packets/second.

vii. The iTM BACnet Server Gateway Option functions shall be configurable through CSV file which shall be downloaded from iTM and configured by trained personnel.

4) System Capacity
i. Max of 128 indoor units groups (Up to 256 indoor units) can be controlled from (BMS)

ii. Max of 8 DIII-Net ports shall be connected to iTM.

5) The Building Management System shall monitor and control the following BACnet objects for indoor units

i. Indoor unit ON/OFF status.

ii. Alarm status with error description

iii. Room temperature.

iv. Indoor Unit ON details
   • Off
   • Normal [ON]
   • Override
   • Setback

v. Filter sign status.

vi. Fan status.

vii. Communication status.

viii. Thermo-on status.

ix. Compressor status
   • On
   • Off
   • Defrost

x. Aux heater status.

xi. Occupancy Mode
   • Unoccupied,
   • Occupied
   • Standby

xii. Operation Mode (Cool, Heat, Fan, and Dry)

xiii. Cooling and Heating setpoints during occupied mode.

xiv. Cooling and Heating setpoints during unoccupied mode.

xv. Maximum and minimum cooling setpoint.

xvi. Maximum and Minimum heating setpoint

xvii. Minimum cooling and heating setpoint differential.

xviii. Fan Speed
   • Up to 3 speeds (dependent upon indoor unit type)

xix. Vane direction (dependent upon indoor unit type)
5 fixed positions or swing position

xx. Remote controller permit/prohibit
   - On/Off
   - Mode,
   - Setpoint

xxi. Filter sign reset for indoor units
xxii. Forced indoor units off.

6) The Building Management System may choose to monitor and control the following BACnet objects linked to iTM control logic:
   i. Enable/Disable iTM Schedule operation.
   ii. Enable/Disable iTM Auto Changeover Operation.
   iii. Set Timed Override Minutes.
       - Monitor and configure timer extension on iTM (30, 60, 90, 120, 150, 180 minutes)
   iv. System forced off
       - Enable/Disable all emergency stop programs that are registered on the iTM.

7) Schedule
   The BMS shall utilize iTM schedule function or support weekly schedule settings through its programming.
   i. BMS schedule shall support the indoor unit:
      - Each scheduled event shall specify time and target group address.
      - Each scheduled event shall include Occupancy Mode, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, and Unoccupied cooling setpoint, Unoccupied heating setpoint, Remote Controller On/Off Permit/Prohibit, Remote Controller Mode Permit/Prohibit, Remote Controller Setpoint Permit/Prohibit, and Timed Override Enable.
      - An override shall be provided for use enabling indoor unit operation during the unoccupied period by the BMS programming.

8) Auto Changeover
   The BMS shall utilize iTM Auto changeover function or support auto-changeover through its programming.
   i. Auto-change shall provide changeover for both Heat Pump and Heat Recovery systems based upon the group configurations. This will allow the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat in accordance with the room temperature and setpoint temperature.
   ii. Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained on the same DIII-Net communication bus to the same outdoor unit in the Heat Pump system or the same branch selector box in the Heat Recovery system.
   iii. Changeover to cooling mode shall occur when the room temperature is great than or equal to the cooling setpoint
       - Differential to be determined by BACnet building management system programming
iv. Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint.
   • Differential to be determined by BACnet building management system programming

v. Guard timer
   • Upon changeover, guard timer will prevent another changeover during this period.
   • Guard timer should be ignored by a change of setpoint manually from the BMS, Intelligent Touch Controller, Remote Controller, or by schedule.
   • Guard timer to be configured by BMS programming (30 minute minimum recommended)

9) Setpoint limitation
   The BMS shall utilize maximum and minimum cooling and heating setpoint to configure upper and lower setpoints range.

10) System shutdown:
    BMS should utilize System forced off point to execute emergency stop program registered on the iTM.

11) Restricted functions:
    The following iTM functions shall be prohibited when the BACnet Server Gateway option enabled:
    i. Interlocking Control.
    ii. Emergency Stop (Emergency stop manual release).
    iii. Power Proportional Distribution (PPD) option.
    iv. BACnet Client option.
    v. D-Net Service.
    vi. External Management Point Registration

A. DCM601A72: iTM Plus Adapter
1. The iTM Plus Adapter shall provide control for all VRV, SkyAir indoor units, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. It shall be capable of handling a maximum of 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The iTM Plus Adapter is to be used in conjunction with intelligent Touch Manager. Up to 7 iTM Plus Adapters can be connected to a single intelligent Touch Manager. This combination will provide intelligent Touch Manager monitoring and control of up to 512 indoor unit groups, 1024 indoor units, and 80 outdoor units. The iTM Plus Adapter shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.

2. The controller wiring shall consist of a non-polar two-wire connection to the outdoor unit at terminals F1F2 (out-out). The iTM Plus Adapter is wall mounted and is used in conjunction with the intelligent Touch Manager to maintain the optimal operation of the connected indoor unit(s). The iTM Plus Adapter is connected to the intelligent Touch Manager via a polarity sensitive 18-2 AWG stranded non-shielded wire (field supplied).

3. The iTM Plus Adapter can be used in conjunction with the BRC1E73 (Navigation Remote Controller), the BRC2A71 (Simplified Remote Controller), or the BRC4C82/7E83/7C812/7E818 (Wireless Remote Controller), BACnet interface, Lonworks interface and Modbus Adapter to control the same indoor unit groups. No more than 2 remote controllers can be placed in the same group. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to
16) together. Manual addressing is required of each indoor unit group associated with the iTM Plus Adapter.

a. Mounting: The iTM Plus Adapter can be mounted on the wall or in a standard enclosure (field supplied).

b. Features: The iTM Plus Adapter shall be approximately 6.30” x 5.87” x 2.41” in size.

c. Basic Operation: Control of all associated indoor unit groups shall be done via the connected Intelligent Touch Manager.

d. Programmability: Programming of all associated indoor unit groups shall be done via the connected intelligent Touch Manager.
PART 1  GENERAL

1.1. PHYSICAL CHARACTERISTICS

A. General:
The local remote control shall be made from plastic materials with a neutral color. Each controller shall have a LCD (Liquid Crystal Display) that shows set point, room temperature, mode of operation (on/off/cool/heat), and fan speed.

1.2. ELECTRICAL CHARACTERISTICS

A. General:
Each indoor unit control circuit board shall supply 16 volts DC to the local remote controller. The voltage may rise or fall in relation to the transmission packets that are sent and received.

B. Wiring:
The control wiring shall be terminated in a daisy chain design from outdoor unit, to branch selector, then daisy chaining to each indoor unit in the system and terminating at the farthest indoor unit. The remote control wiring shall run from the indoor unit control board terminal block to the remote controller connected to that indoor unit.

C. Wiring size:
Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, and 18 AWG stranded copper wire.

1.3. VRV CONTROLS NETWORK

A. The VRV Controls Network is comprised of local remote controllers, multi-zone controllers, advanced multi-zone controllers, and open protocol software devices that transmit information via the high-speed communication bus and may also be controlled via a network PC. The VRV Controls Network supports operation monitoring, scheduling, error e-mail distribution, general user software, tenant billing, maintenance support, and integration with Building Management Systems (BMS) using open protocol via BACnet® or Lonworks® interfaces; all of which blend to provide the optimal control strategy for the best HVAC comfort solution.

PART 2  PRODUCTS

2.1. REMOTE CONTROLLERS

Daikin VRV local remote controllers are compatible with all VRV indoor units. The remote controller wiring consist of a non-polar two-wire connection to the indoor unit. The local remote controllers may be wall-mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s). Temperature setpoint can be adjusted in increments of 1°F/°C. In the cases where a system or unit error may occur, the VRV controllers will display a two-digit error code and the unit address. The local remote controllers do not need to be addressed.

A. Navigation Remote Controller
1. BRC1E73
2. BRC1E72

B. Simple Remote Controller
1. BRC2A71

C. Wireless Remote Controller
   3. BRC4C82
   4. BRC7E83
   5. BRC7C812
   6. BRC7E818

D. Remote Temperature Sensor
   1. KRCS01-1B

PART 3 SPECIFICATIONS

3.1. NAVIGATION REMOTE CONTROLLER

A. BRC1E73: Navigation (NAV) Remote Controller
   The NAV Remote Controller can provide control for all VRV indoor units. The remote controller wiring consist of a non-polar two-wire connection to the indoor unit at terminals P1/P2. The NAV Remote Controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s). The NAV Remote Controller does not need to be addressed.

   The NAV Remote Controller can be used in conjunction with the BRC2A71 (Simplified Remote Controller) or another NAV Remote Controller to control the same indoor unit group. No more than 2 remote controllers can be placed in the same group.

   1. Mounting: The NAV Remote Controller shall be mounted into a standard 2” x 4” junction box.

   2. Display Features:
      a. The NAV Remote Controller shall be approximately 4.75” x 4.75” in size with a 2.75” x 1.75” LCD display.
      b. Backlit LCD display with contrast adjustment and auto off after 30 seconds.
      c. Display language shall be selectable from English, French or Spanish.
      d. Selectable display – Detailed, Standard and Simple
         1) Detailed display
            i. Shall display Operation Mode, Cool, Heat and Setback setpoints, Fan Speed, Louver position, Room Temperature, Time and Day of the Week
         2) Standard display
            i. Shall display Operation Mode, Cool, Heat and Setback setpoints and Fan Speed
         3) Simple display
            i. Shall display Operation Mode, Cool, Heat and Setback setpoints, Fan Speed and Room Temperature
            ii. The room temperature shall be displayed with a large 11/16” font
      e. All displayed items configurable
         1) Configure “Off” to be displayed when unit is turned off (field setting required)
            i. Prevents mode adjustment
         2) Setpoint can be removed from display when unit is turned Off (field setting required)
            i. Prevents setpoint adjustment
3) Fan speed display removable (field setting required)
   i. Prevents fan speed adjustment
f. System Status icons.
g. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F (16-32°C)
h. Detailed and Simple display will reflect room temperature (0-176°F/-18-80°C range in one degree increments).
   1) Display of temperature information shall be configurable for Fahrenheit or Celsius
i. On/Off status shall be displayed with an LED.
j. Error codes will be displayed with a two digit code in the event of system abnormality/error.
   1) A blinking LED will also signal system abnormality/error
k. The following system temperatures can be displayed to assist service personnel in troubleshooting:
   1) Return Air Temperature
   2) Liquid Line Temperature
   3) Gas Line Temperature
   4) Discharge Air Temperature (depending on unit),
   5) Remote Controller Sensor Temperature
   6) Temperature used for Indoor Unit Control

3. Basic Operation:
   a. Capable of controlling a group of up to 16 indoor units.
   b. Controller shall control the following group operations:
         i. Configure only the essential modes to be selectable – remove unnecessary mode selection(s) from display
      2) Independent Cooling and Heating setpoints in the occupied mode
         i. Dual setpoints (individual Cool and Heat setpoints with minimum setpoint differential 0 – 7°F (0 – 4°C) default 2°F (1°C)) or Single setpoint
      3) Independent Cooling Setup and Heating Setback setpoints in the unoccupied mode
      4) Fan Speed
         ii. Up to 5 speeds (dependent on indoor unit type)
      5) Vane direction and oscillation (dependent on indoor unit type)
         iii. Airflow direction
            1. Up to 5 louver positions and auto swing
         iv. Individual airflow
            1. Provides individual control of up to four (4) louver positions on an indoor unit
         v. Dual airflow
            1. Provides control of both internal and external louver positions
         vi. Automatic draft protection
            1. Automatically prevents air flow from blowing directly on occupants
   b. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
   c. Function button lockout (On/Off, Mode, Fan Speed, Up/Down, Left, Right Arrows)
d. Optional Controller Face Decal (BRC1E72RM, BRC1E72RF, BRC1E72RMF, BRC1E72RM2, BRC1E72RF2, BRC1E72RMF2) to hide unnecessary (locked out) buttons

e. Indoor Unit group assignment

f. Filter indicator
   1) Filter service indicator shall be displayed after 100, 1250 or 2500 (default) hours of run time configurable via field setting

g. Clock (12/24 hour) and Day display

h. Automatic adjustment for Daylight Savings Time (DST)
   1) Set changeover period (second Sunday in March / first Sunday in November)

4. Programmability:
   a. Controller shall support schedule settings with selectable weekly pattern options.
      1)7-day
      2)Weekday + Weekend
      3)Weekday + Saturday + Sunday
      4)Everyday
      5)The schedule shall support unit On/Off
      6)Independent settings for Cooling and/or Heating setpoints when unit is on (occupied)
      7)Independent Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied)
      8)A maximum of 5 operations can be schedulable per day
      9)Time setting in 1-minute increments

   b. The Controller shall support Auto-changeover mode for both Heat Pump and Heat Recovery systems, therefore, allowing the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat according to the room temperature and temperature setpoint.
      1)Changeover to cooling mode shall occur at cooling setpoint + 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      2)Changeover to cooling mode shall occur at the primary changeover deadband to cooling + 1°F (0.5°C) as the secondary changeover deadband.
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      3)Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      4)Changeover to heating mode shall occur at the primary changeover deadband to heating - 1°F (0.5°C) as the secondary changeover deadband.
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      5)1 hour guard timer
         i. Upon changeover, guard timer will prevent another changeover during this period.
         ii. Guard timer is ignored by a change of setpoint manually from either the Multi-zone Controller, Remote Controller, or by schedule.
iii. The Guard timer is also ignored if the space temperature reaches the secondary changeover deadband (configurable from 1 - 4°F (0.5 – 2°C)) from the primary changeover deadband, and the guard timer has been activated

iv. 60 minutes as default, configurable to 15, 30, or 90 minutes

c. The controller shall support the Auto-setback by sensor function (dependent on indoor unit type)

1) The cooling and heating setpoints shall gradually relax (configurable) internally when the room is determined to be unoccupied

i. The internal setpoint shall return to the original setpoint when room occupancy is detected

d. The controller shall support the Auto-off by sensor function (dependent on indoor unit type)

1) The indoor unit shall turn off when it is determined that the room is unoccupied after a specified time has elapsed

i. The indoor unit shall be turned on manually when occupancy is detected

e. The controller shall support the Filter Auto Clean function to be performed once a day (dependent on indoor unit type)

1) Eight (8) time periods (00:00-03:00, 03:00-06:00, 06:00-09:00, 09:00-12:00, 12:00-15:00, 15:00-18:00, 18:00-21:00, 21:00-00:00) shall be available to select from to enable the automatic filter cleaning function

i. Default time period (00:00 to 3:00) shall be used if the period for filter auto cleaning is not specified

2) The indoor unit shall be stopped during auto filter cleaning function operation

f. The Controller shall support an Auto Off Timer for temporarily enabling indoor unit operation during the unoccupied period.

1) When the Off Timer is enabled and when the unit is manually turned on at the remote controller

2) The controller shall shut off the unit after a set time period

3) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments

g. The room temperature shall be capable of being sensed at either the NAV Remote Controller, the Indoor Unit return air temperature sensor (default), or Remote Temperature Sensor (KRCS01-1B) configured through the field settings.

B. BRC1E72: Navigation (NAV) Remote Controller

The NAV Remote Controller can provide control for all VRV indoor units. The remote controller wiring consist of a non-polar two-wire connection to the indoor unit at terminals P1/P2. The NAV Remote Controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s). The NAV Remote Controller does not require addressing.

The NAV Remote Controller can be used in conjunction with the BRC2A71 (Simplified Remote Controller) or another NAV Remote Controller to control the same indoor unit group. No more than 2 remote controllers can be placed in the same group.

1. Mounting:

   The NAV Remote Controller shall be mounted into a standard 2” x 4” junction box.

2. Display Features:
a. The NAV Remote Controller shall be approximately 4.75” x 4.75” in size with a backlit 2.75” x 1.75” LCD display.
b. Feature Backlit LCD Display with contrast adjustment and auto off after 30 seconds.
c. Display information shall be selectable from English, French, or Spanish.
d. Configurable display mode – Detailed, Standard, and Simple
   1) Large 11/16” room temperature displayed in Simple display
h. The controller shall display Operation Mode, Setpoint, and Fan Speed.
   1) Displayed items configurable
   2) Configure “Off” to be displayed when unit is turned off (field setting required)
      i. Prevents mode adjustment
   3) Setpoint can be removed from display when unit is turned Off (field setting required)
      i. Prevents setpoint adjustment
   4) Fan speed display removable (field setting required)
      i. Prevents fan speed adjustment
i. System Status icons.
j. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F (16-32°C)
k. Detailed and Simple display will reflect room temperature (0-176°F/-18-80°C range in one degree increment).
   1) Display of temperature information shall be configurable for Fahrenheit or Celsius
l. On/Off status shall be displayed with an LED.
m. Error codes will be displayed in the event of system abnormality/error with a two digit code.
   1) A blinking LED will also signal system abnormality/error
n. The following system temperatures can be displayed to assist service personnel in troubleshooting:
   1) Return Air Temperature
   2) Liquid Line Temperature
   3) Gas Line Temperature
   4) Discharge Air Temperature (depending on unit),
   5) Remote Controller Sensor Temperature
   6) Temperature used for Indoor Unit Control

3. Basic Operation:
   a. Capable of controlling a group of up to 16 indoor units.
   b. Controller shall control the following group operations:
         i. Configure only the essential modes to be selectable – remove unnecessary mode selection(s) from display
      2) Independent Cooling and Heating setpoints in the occupied mode
         i. Dual setpoints (individual Cool and Heat setpoints with minimum setpoint differential 0 – 8°F (0 – 4°C) default 2°F (1°C)) or Single setpoint
   c. Independent Cooling Setup and Heating Setback setpoints in the unoccupied mode
   d. Fan Speed
   e. Airflow direction (dependent on indoor unit type).
   f. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
g. Function button lockout (On/Off, Mode, Fan Speed, Up/Down, Left, Right Arrows)

h. Optional Controller Face Decal (BRC1E72RM, BRC1E72RF, BRC1E72RMF, BRC1E72RM2, BRC1E72RF2, BRC1E72RMF2) to hide unnecessary (locked out) buttons

i. Indoor Unit group assignment

j. Filter indicator
   1) Filter service indicator displayed after 100 or 2500 (default) hours of run time configurable via field setting

k. Clock (12/24 hour) and Day display

l. Automatic adjustment for Day Light Savings Time (DST)
   1) Set changeover period (second Sunday in March / first Sunday in November)

4. Programmability:
   a. Controller shall support schedule settings with selectable weekly pattern options.
      1) 7-day
      2) Weekday + Weekend
      3) Weekday + Saturday + Sunday
      4) Everyday
      5) The schedule shall support unit On/Off
      6) Independently settable Cooling and/or Heating setpoints when unit is on (occupied)
      7) Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied)
      8) A maximum of 5 operations can be schedulable per day
      9) Time setting in 1-minute increments

   b. The Controller shall support auto-changeover mode for both Heat Pump and Heat Recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat according to the room temperature and temperature setpoint.
      1) Changeover to cooling mode shall occur at cooling setpoint + 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      2) Changeover to cooling mode shall occur at the primary changeover deadband to cooling + 1°F (0.5°C) as the secondary changeover deadband.
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      3) Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      4) Changeover to heating mode shall occur at the primary changeover deadband to heating - 1°F (0.5°C) as the secondary changeover deadband.
         i. Configurable from 1 – 4°F (0.5 – 2°C)
      5) 1 hour guard timer
         i. Upon changeover, guard timer will prevent another changeover during this period.
            1. Guard timer is ignored by a change of setpoint manually from either the Multi-zone Controller, Remote Controller, or by schedule.
            2. The Guard timer is also ignored if the space temperature reaches the secondary changeover deadband
3. The Controller shall support an Auto Off Timer for temporarily enabling indoor unit operation during the unoccupied period.
   a. When the Off Timer is enabled and when the unit is manually turned on at the remote controller
   b. The controller shall shut off the unit after a set time period
   c. The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments

d. The room temperature shall be capable of being sensed at either the NAV Remote Controller, the Indoor Unit return air temperature sensor (default), or Remote Temperature Sensor (KRCS01-1B) configured through the field settings.

3.2. SIMPLIFIED REMOTE CONTROLLER

A. BRC2A71: Simplified Remote Controller
   The Simplified Remote Controller can provide control for all VRV indoor units. The remote controller wiring consists of a non-polar two-wire connection to the indoor unit at terminals P1/P2. The Simplified Remote Controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s). The Simplified Remote Controller does not require addressing.

   The Simplified Remote Controller can be used in conjunction with the BRC1E71 (Navigation Remote Controller) or another Simplified Remote Controller to control the same indoor unit group. No more than 2 remote controllers can be placed in the same group.

1. Mounting:
   The Simplified Remote Controller shall be mounted into a standard 2" x 2" junction box.

2. Display Features:
   a. The Simplified Remote Controller shall be approximately 4.75" x 2.75" in size with a 1" x 1.75" LCD display.
   b. The controller shall display Operation Mode, Setpoint, and Fan Speed.
   c. The controller shall be able to display temperature setpoint in one degree increments with a range of 60-90°F (16-32°C).
   d. On/Off status shall be displayed with an LED.
   e. Error codes will be displayed in the event of system abnormality/error with a two digit code.
      1) A blinking LED will also signal system abnormality/error

3. Basic Operation:
   a. Capable of controlling a group of up to 16 indoor units.
   b. Controller shall control the following group operations:
      1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery System))
      2) Independent Cooling and Heating setpoints in the Occupied mode
      3) Independent Cooling Setup and Heating Setback setpoints in the Unoccupied mode,
4) Set fan speed
5) The controller shall be able to limit the user adjustable setpoint ranges
   individually for cooling and heating in the occupied period
6) Indoor unit group assignment
7) Function key lockout (Mode / Fan Speed) via Optional Controller Face
   Plates (BRC2A71RU / BRC2A71R)

3.3. WIRELESS REMOTE CONTROLLER

A. BRC4C82 / BRC7E83 / C812 / E818: Wireless Remote Controller
The Wireless Remote Controller can provide control for all VRV indoor units. The remote
controller wiring consists of a non-polar two-wire connection to the indoor unit at
terminals P1/P2. The Wireless Remote Controller is wall mounted and can be adjusted
to maintain the optimal operation of the connected indoor unit(s). The Wireless Remote
Controller does not require addressing.

The Wireless Remote Controller can be used in conjunction with the BRC2A71
(Simplified Remote Controller) or another Wireless Remote Controller to control the same
indoor unit group. No more than 2 remote controllers can be placed in the same group.

1. Mounting:
   a. The Wireless Remote Controller receiver shall be mounted on the wall or on
      the indoor unit (dependent on indoor unit model type).

2. Display Features:
   a. The Wireless Remote Controller shall be approximately 6.25” x 2.75” in size
      with a 3.75” x 0.75” LCD display.
   b. The controller shall be able to display Operation Mode, Setpoint and Fan
      Speed.
   c. The controller shall be able to display temperature setpoint in one degree
      increments with a range of 60-90°F (16-32°C).
   d. Error codes will be displayed in the event of system abnormality/error with a
      two digit code.
      1) A blinking LED will also signal system abnormality/error

3. Basic Operation:
   a. Capable of controlling a group of up to 16 indoor units.
   b. Controller shall control the following group operations:
      1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV
         Heat Recovery System))
      2) Independent Cooling and Heating Setpoints in the occupied mode
      3) Fan Speed
      4) Air flow direction (dependent on indoor unit type)
      5) Indoor unit group assignment

4. Programmability:
   a. Supports timer controlled start/stop operation (up to 72 hours).

3.4. REMOTE TEMPERATURE SENSOR

A. KRCS01-1B: Remote Temperature Sensor
The Remote Temperature Sensor can provide temperature sensing for all VRV indoor
units. The remote controller wiring consists of a non-polar two-wire connection to the
indoor unit at terminals X13A. The Remote Temperature Sensor is wall mounted and is used to maintain the optimal operation of the connected indoor unit.

The Remote Temperature Sensor can be used in conjunction with the Navigation Remote Controller, Simplified Remote Controller, and the Wireless Remote Controller to sense space temperature outside of the indoor unit. No more than 2 remote controllers can be placed in the same group.

1. Mounting:
   a. Sensor Box shall be 2.38” x 1.97” x 0.75” (H x W x D) in size.
   b. Can be mounted on the wall in the provided sensor box.
   c. Can be mounted in the Simplified Remote Controller (BRC2A71).
   d. Can be mounted in a button temperature sensor holder (field supplied).

2. Application:
   a. The location of the temperature sensor should provide a realistic sample of the space temperature in order to provide the optimum comfort level to the occupants.
      1) Things that need to be considered are:
         i. Indoor unit location
         ii. Will outside area be brought into the space and/or indoor unit
         iii. Ceiling heights
         iv. Control Scheme
         v. Design and limitations due to architecture
         vi. Plenum air return

3. Basic Operation:
   a. Replaces indoor unit return air temperature sensor.
      1) Senses room temperature for only one indoor unit

END OF SECTION
PART 1 - GENERAL

1.01 SCOPE:

A. All low pressure duct work including supply, exhaust, and outside air to complete the systems as shown on the Drawings or specified herein.

1.02 SUBMITTALS:

A. Submit the following:

1. Air distribution devices.
2. Life safety dampers and doors.
3. Flexible duct.
4. Flexible connections.
5. Access doors and duct access doors.
6. Turning vanes.
7. Duct take-off, fittings.
8. Roof outside air intake.
10. Duct leak tests.

1.03 GOVERNING PUBLICATIONS AND AUTHORITIES:

A. ASHRAE "Guide".
B. SMACNA "Low Velocity Duct Construction Standards".
C. Underwriters' Laboratories, Inc.
D. NFPA Pamphlets No. 90A, 90B, 91 and 96.

PART 2 - PRODUCTS

2.01 DUCT MATERIALS:

A. Galvanized steel sheets shall be lock-forming quality (LFQ), shall have a galvanized 690 zinc coating of 1-1/4 oz. total for both sides of one square foot, and the gauge of galvanized steel sheets shall be as prescribed by the latest edition of SMACNA for pressure classification of ductwork.

B. Aluminum sheets shall be made from an aluminum base alloy having not more than
0.5% copper (for corrosion resistance), a minimum tensile strength of 16,000 psi and the ability to satisfactorily make a Pittsburgh lock seam without splitting.

2.02 FLEXIBLE CONNECTIONS:

A. Flexible connections shall be made on duct connections of air moving equipment greater than 2000 CFM or as required for equipment installation.

B. Connections shall be made of 30 ounce woven glass fabric; fire-, water-, and weather-resistant fabric equal to “Ventfab”, double coated with neoprene “Ventglas”, or equal. Canvas connections to give no less than 3” clear break between metals jointed. Insulate with 1” minimum fiberglass duct wrap with a vapor barrier facing of foil reinforced kraft. Seal with reinforced aluminum tape.

C. Flexible connections on exterior shall be protected from weather with sheetmetal cover which shall be coated for protection same as ductwork.

D. Connections in high pressure systems, fume hoods, and for those exposed to the weather shall be made from “Ventglas”, neoprene coated glass fabric.

2.03 ACCESS DOORS:

A. Access doors to 16” by 24” size shall be “Ventlock” stamped insulated access doors.

B. Larger access doors shall be double panel construction with one inch thick 1.5 pcf density rigid insulation between panels. Doors with largest dimension over 24”, but less than 48”, shall use “Ventlock” series 200 latches, hinges and gasketing, and construction shall be 22 gage galvanized steel. Doors with largest dimension over 48” shall use “Ventlock” series 300 latches, hinges and gasketing, and construction shall be 20 gage galvanized steel.

C. Provide vision panels on access doors for fire dampers and control dampers.

2.04 FLEXIBLE DUCT:

A. Low Pressure: furnish and install, where indicated on the drawings, flexible metal insulated round ductwork, factory fabricated, listed under U.L. #181, Class 1 and NFPA 90A, capable of a minimum centerline bend radius equal to duct inside diameter. Insulation shall be 1-1/2" thick, 3/4 lb. density fiberglass blanket, maximum "K" value of 0.25 btu-in/hr-ft5-EF., and vapor barrier shall be neoprene coated fiberglass fabric laminated to aluminized polyester film. Flexible duct shall be rated for 10" positive and 2" negative static pressure.

B. Vinyl or non-aluminized vapor barriers will not be allowed. Maximum runouts shall not exceed length indicated on drawings in notes or details.

2.05 AIR DISTRIBUTION DEVICES:

A. General:

1. All outlet grilles shall have gaskets.
2. Furnish opposed blade volume controls on all supply outlets and return grilles.

B. Devices: Devices shall be as scheduled on the drawings.

2.06 LIFE SAFETY DAMPERS:

A. Dampers shall be equal to those manufactured by the Ruskin Corporation or Greenheck.

B. Dampers shall be U.L. listed.

C. Fire, smoke or combination fire/smoke dampers shall be provided in rated assemblies requiring them.

D. All dampers, methods and location of installation shall comply with the requirements of the International Building Code, National Fire Protection Association and all authorities having jurisdiction. In the case of discrepancies, most stringent requirements shall dictate installation.

E. Fire and smoke dampers shall be provided with an approved means of access, large enough to permit inspection and maintenance of the damper and its operating parts. Access shall be provided on either side of damper assemblies.

F. Access shall not affect the integrity of fire-resistance-rated assemblies. The access openings shall not reduce the fire-resistance rating of the assembly.

G. Provide access door minimum 12” x 12”.

H. Access points shall be permanently identified on the exterior by a label having letters not less than 0.5 inch (12.7 mm) in height reading: fire/smoke damper, smoke damper or fire damper.

I. Access doors in ducts shall be tight fitting and suitable for the required duct construction. Contractor shall install dampers in accordance with the following:

J. Fire dampers shall be constructed and tested in accordance with UL Safety Standard 555. Dampers shall have an hourly rating as indicated on the drawings, a 212°F fusible link, and shall include a UL label.

K. All outlet grilles shall have gaskets.

L. Contractor shall furnish opposed blade volume controls on all supply outlets and return grilles.

M. Dampers shall be equipped for vertical or horizontal installation as required by the location.

N. Manufacturer’s integral sleeves and frames may be used at the contractor’s option.

O. Dampers shall be provided which are tested and rated for design duct velocity and
 pressure.

P. Dampers rating shall meet or exceed the rating of the wall in which it is housed.

Q. Contractor shall install fire or smoke or combination dampers in all rated walls as necessary to maintain the integrity of all rated walls whether indicated on the plans or not.

2.07 ACCESSORIES:

A. Manufactured Turning Vanes: Furnish and install single thickness, multiple radius, airfoil steel turning vanes. Static pressure loss for square ducts shall be no more than 20% of velocity head. Turning vanes shall be furnished with a mounting plate to facilitate installation in ductwork.

B. Manual Balancing Damper:
   1. Square or Rectangular: Minimum 16 ga. body and 18 ga. blades, equal to Ruskin or Greenheck with vinyl blade seal and locking hand operator quadrant.
   2. Round: Minimum 20 ga. body and 22 ga. blades, equal to Ruskin or Greenheck with locking hand operator

C. Control Dampers:
   1. Control dampers shall be furnished by AHU Manufacturer or Control System.

D. All dampers shall be capable of 100% seal off.

PART 3 - EXECUTION

3.01 GENERAL:

A. All ductwork not specifically indicated on drawings or specified elsewhere to be high-pressure duct shall be fabricated, braced and erected in accordance with SMACNA "Low Velocity Duct Construction Standard" or the latest edition of ASHRAE "Guide".

B. Ductwork shall be galvanized steel unless otherwise noted.

C. Stainless steel and aluminum ductwork shall welded seam.

D. Adhere to drawings as closely as possible. However, where required to meet structural or other interferences vary the run and shape of ducts and make offsets during progress of work. Duct routes shall be established and field measurements shall be taken before duct work is fabricated. Where pipes or other items are "taken-in" to the duct, streamline collars shall be formed and placed around the item. If collar obstructs more than 20% of the cross sectional area, the duct shall be enlarged to accommodate obstruction.

E. All changes of direction and elbows shall be fitted with turning vanes. Standard
radius elbows may be used if space permits.

F. Ductwork shall be free of any objectionable self-generating noise or rattles.

G. Furnish and install shop fabricated ductwork. Pre-assemble work in shop to the greatest extent possible, so as to minimize field assembly of systems. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible.

H. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with centerline radius equal to associated duct width. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.

I. Duct Sealing: All ductwork, regardless of system pressure classification, shall be sealed in accordance with Seal Class A, as referenced in SMACNA Standards. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.

1. All seams and joints in shop and field fabricated ductwork shall be sealed by applying duct sealant complying with manufacturer’s recommendations. Tapes recommended by the sealant manufacturer may used in addition to sealant to achieve leakage limit requirements.

2. Sealant shall be water based latex UL 181A-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be Hard Cast Iron Grip 601, Ductmate Pro Seal, Foster 32-19, Childers CP-146 or Design Polymerics DP 1010.

3. Sealing tapes shall be from the same manufacturer as duct sealants.

4. Sealer shall be rated by the manufacturer and shall be suitable for use at the system pressure classification of applicable ductwork.

5. Except as noted, oil or solvent-based sealants are specifically prohibited.

6. For exterior applications, “Uni-Weather” (United McGill Corporation), solvent-based sealant, or Foster 32-19 shall be used.

J. Support materials shall be hot dipped galvanized steel fasteners, anchors, rods, straps, trim and angles. (Support duct with all thread rods and unistrut as equal trapeze hangers).

K. Install air flow measuring stations, furnished by Control Contractor, where indicated on the drawings.

3.02 MANUAL BALANCING DAMPERS:

A. All low pressure branch ducts on either supply, return or exhaust shall be provided by some means of balancing in addition to dampers at registers.

B. Splitter dampers shall be made of at least the same thickness material as duct (minimum thickness 22 gage). They shall be securely hinged at air leaving edge and made of 2 thicknesses so that entering edge presents a rounded surface to air flow.
C. Butterfly dampers shall be made of 16 gage galvanized steel. Butterfly dampers may be used in widths up to 10" wide. Dampers that require blades over 10" wide shall be multi-blade louver dampers.

D. Multi-blade louver dampers used for balancing shall be of the opposed blade type. Damper blades shall be constructed of 16 gage steel. Individual blade width shall not exceed 10" and blade length shall not exceed 48".

E. All dampers shall be so constructed and installed that there shall be no vibration due to air flow over damper.

F. Extend all handles and levers to outside of insulation.

3.03 ACCESS DOOR:

A. Access doors shall be provided at all dampers, equipment in duct and as indicated on drawings.

B. Access doors shall be minimum of 12" X 12" unless a larger size is required for maintenance of equipment or a smaller size must be used because of small duct size.

C. Provide access doors at all fire dampers, smoke dampers, humidifiers, and as indicated on the drawings.

3.04 FLEXIBLE CONNECTIONS:

A. Furnish and install sound isolating flexible connections on the inlet and outlet of each fan and unit to which duct connectors are made.

B. At least one inch slack shall be allowed in these connections to insure that no vibration is transmitted from fan to ductwork.

C. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent air leakage.

3.05 FLEXIBLE DUCT

A. Maximum runout shall not exceed lengths indicated on drawings.

B. Ducts shall be supported at intervals indicated in SMACNA and not laid on top of ceiling.

C. Minimum bend radius shall be as recommended by manufacturer.

D. Ducts shall be run straight and true with minimum offsets, and with excess duct lengths removed.

E. Connections to ducts and air devices shall be with minimum of one duct diameter straight into connection (kinked or pinched installations restricting flows are not acceptable).
F. Connections to duct and air devices shall be air tight.

3.06 TESTS:

A. Test duct systems in accordance with SMACNA latest edition of HVAC Air Duct Leakage Test Manual to achieve air tight systems not exceeding the limits outlined in the manual. Submit test results.

END OF SECTION
PART 1 – GENERAL

1.01 Provide extruded aluminum louvers as shown on the plans and schedules.

1.02 SUBMITTTALS

A. Provide manufacturer’s product data including dimensions, details of construction, assembly, performance characteristics, and pressure drop curves.

B. Provide certified product test data for water penetration.

C. Provide manufacturer’s installation instructions with maintenance data.

1.03 REGULATORY REQUIREMENTS:

A. AMCA: louver to be AMCA certified for water penetration and performance.

1.04 DELIVERY, STORAGE, AND PROTECTION

A. Accept materials on site in original factory packaging, labeled with manufacturer’s identification, including product installation instructions.

B. Protect from weather and construction traffic, dirt, water, chemical and mechanical damage by storing in original shipping crates.

PART 2 – PRODUCTS

2.01 DETAILS OF CONSTRUCTION

A. Refer to Mechanical Schedule in the Project Drawings for Basis of Design. Louver construction shall be equal to Basis of Design.

B. Blades shall be drainable type with removable bird screen.

C. Color and finish to be as scheduled; coordinate with Architect or Owner’s Representative for final finish and color if none are scheduled.

2.02 APPROVED MANUFACTURER

A. Provide louvers as manufactured by Ruskin, American Warming and Ventilating, Greenheck, or equal.

PART 3 – EXECUTION

3.01 EXAMINATION:

A. The Contractor, prior to installation, shall examine the conditions under which the louver is to be installed, and shall notify the Architect or Engineer of conditions detrimental to proper installation.

3.02 INSTALLATION:
A. Install in accordance with manufacturer's instructions and applicable codes.

B. Locate and place louver plumb, level and in proper alignment with adjacent work.

C. Secure louver using concealed anchorages where possible.

D. Protect non-ferrous metal surfaces from corrosion or galvanic action by applying bituminous paint on surfaces that will be in contact with concrete, masonry or dissimilar metal.

E. As work progresses install concealed gaskets and flashings. Install sealant in joints as required to make installation weathertight.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY:

A. This section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities and temperatures of the mechanical systems as required to meet design specifications, and recording and reporting the results.

1. Test, adjust, and balance the following mechanical systems:
   a. Exhaust air systems.
   b. Outside air systems.
   c. Verify control system operation.

2. Contractor shall:
   a. Put heating, ventilating, and air conditioning systems and equipment into full operation and continue the operation of same during each working day of testing and balancing.
   b. Allow the air balance agency to schedule this work in cooperation with other trades involved and comply with the completion date.
   c. Make available to the balance agency a complete copy of submittal data on mechanical equipment including pump performance curves, fan curves, manufacturer’s balancing factors and other manufacturers ratings for installed equipment.
   d. Make any changes in pulleys, belts, and dampers or the addition of dampers as required for correct balance as recommended by TAB Contractor, at no additional cost to the Owner.
   e. Have strainers and filters clean prior to starting of testing and balancing activity.

B. This section does not include:

1. Specifications for materials for patching mechanical systems.
2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
3. Requirements and procedures for piping and ductwork systems leakage tests.

1.02 DEFINITIONS:

A. Systems testing, adjusting, and balancing is the process of checking and adjusting
building environmental systems to produce design objectives. It includes:

1. Balance of air distribution;
2. Adjustment of total system to provide design qualities;
3. Electrical measurement;
4. Verification of performance of equipment and automatic controls;

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (mains, branches, and terminals) according to specified design quantities.

E. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.

F. Terminal: The point where controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

1.03 SUBMITTALS:

A. Agency Data: Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.

B. Technicians Data: Submit proof that the Test and Balance Staff assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.

D. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems.

E. Sample Forms: Submit sample forms.

F. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Technician. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.

G. Draft Reports: Upon completion of testing, adjusting, and balancing procedures,
prepare draft reports on the approved forms. Draft reports may be hand written, but
must be complete, factual, accurate, and legible. Organize and format draft reports in
the same manner specified for the final reports. Submit 2 complete sets of draft
reports. Only 1 complete set of draft reports will be returned.

H. Final Report: Upon verification and approval of draft reports, prepare final reports,
type written, and organized and formatted as specified below. Submit 2 complete
sets of final reports.

I. Report Format: Report forms shall be those standard forms prepared by the
referenced standard for each respective item and system to be tested, adjusted, and
balanced. Bind report forms complete with schematic systems diagrams and other
data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the
project identification and a title descriptive of the contents. Divide contents of binder
into the below listed divisions, separated by divider tabs:

1. General Information and Summary
2. Air Systems
3. Temperature Control Systems

J. Report Contents: Provide the following minimum information, forms and data:

1. General Information And Summary: Inside cover sheet to identify testing,
   adjusting, and balancing agency, Contractor and Project. Include addresses,
   and contact names and telephone numbers. Also include a sheet containing
   the seal and name address, telephone number, and signature of the Certified
   Test and Balance Technician. Include in this division a listing of the
   instrumentations used for the procedures along with the proof of calibration.

2. The remainder of the report shall contain the appropriate forms for each
   respective item and system. Prepare a schematic diagram for each item of
   equipment and system to accompany each respective report form.

3. Air systems report shall include the following:
   a. blower RPM;
   b. motor full load amperes and voltages;
   c. system static pressures, suction and discharge;
   d. cfm outside air (for demand controlled ventilation with CO2 sensors,
      provide airflow readings at 2 different CO2 levels;
   e. entering air temperatures; DB/WB
   f. leaving air temperatures; DB/WB
   g. main supply, return, and exhaust air ducts cfm, (pitot transverse);
   h. each diffuser, grille and register cfm. (Balance to within +/-10% of
design requirements and pressure relationships shown on drawings.)
i. each grille, diffuser, and register shall be identified as to location and area;

j. copies of start-up logs;

k. space temperatures and humidity readings; DB/WB

l. pressure drops across coils, filters, dampers, and other equipment in ducts.

m. pressure profiles of each system.

K. Calibration Reports: Submit proof that required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of 6 months prior to starting the project.

1.04 QUALITY ASSURANCE:

A. Agency Qualifications:

1. Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

2. The independent testing, adjusting, and balancing agency shall be certified by National Environmental Balancing Bureaus (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Technician, certified by NEBB or AABC.

B. Codes and Standards:

1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".

2. AABC: "National Standards for Total System Balance".


C. Pre-Balancing Conference: Prior to beginning testing, adjusting, and balancing procedures, schedule and conduct a conference with the Contracting Officer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.05 PROJECT CONDITIONS:

A. Systems Operation: Systems shall be fully operational prior to beginning procedures.
1.06 ACCEPTANCE:
The Contracting Officer will not accept the building until the systems have been properly started, balanced, and the TAB Report is approved.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.01 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING:
Before operating the system, perform these steps:

A. Obtain design drawings and specifications and become thoroughly acquainted with design intent.

B. Obtain copies of approved shop drawings of air handling equipment, outlets (supply and return) and temperature control diagrams.

C. Compare design to installed equipment and field installations.

D. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.

E. Check filters for cleanliness.

F. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.

G. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

H. Determine best locations in main and branch ductwork for most accurate duct traverses.

I. Place outlet dampers in full open position.

J. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

K. Verify that motors and bearings have been lubricated.

L. Check fan belt tension.

M. Check fan rotation.

3.02 MEASUREMENTS:

A. Provide required instrumentation to obtain proper measurements, calibrated to the tolerances specified in referenced standards. Instruments shall be properly maintained and protected against damage.
B. Provide instruments meeting the specifications of the referenced standards.

C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

3.03 PERFORMING TESTING, ADJUSTING, AND BALANCING:

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.

B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

C. Patch insulation, ductwork, and housings, using materials identical to those removed.

D. Seal ducts and piping, and test for and repair leaks.

E. Seal insulation to re-establish integrity of the vapor barrier.

F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar control and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.04 CONTROL SYSTEM VERIFICATION:

A. In conjunction with Control System Vendor, during the process of TAB work, manipulate control system devices as required to facilitate necessary system TAB. Provide listing of control system components and/or sequences that are not operating properly in TAB report and to Control System Vendor.

3.05 RECORD AND REPORT DATA:

A. Record data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by referenced standards, and as approved on sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

3.06 DEMONSTRATION:

A. Training:

1. Train maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with personnel the information contained in Operating and Maintenance Data.
2. Schedule training through the Owner with at least 7 days' prior notice.

END OF SECTION
203.998 Mobilization Bid Item – A mobilization bid item is included to help cover initial costs of bonds, insurance, permits, submittal preparation and other incidental costs.

203.998.1 Payment shall be made for a Mobilization Bid Item which is intended to cover the costs of bonds, insurance, permits, submittal preparation and other incidental costs. Payment of the Mobilization Bid Item may be requested in full on the first payment application. The Mobilization Bid Item shall not exceed five percent (5%) of the sum of all Base Bid Items excluding the Mobilization Bid Item. Add Alternate Items are not part of the Base Bid Items.

END OF SECTION
203.999  **Mechanical, Electrical, Plumbing, and Unforeseen Circumstances Allowance** –

$20,000.00 Lump Sum Allowance for various mechanical, electrical, plumbing, or unforeseen circumstances work not shown on the Construction Drawings or specified in the Contract Documents.

- **203.999.1** The allowance shall be used for cost of materials, labor, installation, and overhead and profit for additional MEP/Unforeseen Circumstances work that is not shown on the Construction Drawings or specified in the Contract Documents.

- **203.999.2** The allowance shall be used only at the discretion of the Regional Metropolitan Utility Authority (RMUA). Any allowance balance remaining at the completion of the contract will be credited back to the RMUA on the final Application for Payment submitted by the contractor.

- **203.999.3** The contractor shall provide to the RMUA’s representative a written request for the use of any of the allowance with a schedule of values and all associated backup information.

- **203.999.4** The contractor shall proceed with work included in the allowance only after receiving a written order from the RMUA’s representative authorizing such work. Proceeding with work expected to be covered in the allowance without a written order from the RMUA’s representative will be at the contractor’s risk. Contractor may not be paid for unapproved work/materials at the discretion of the RMUA’s representative.

- **203.999.5** Any additional costs for bonds and insurance shall not be included in any MEP allowance because this cost is already included in the contract.

**END OF SECTION**
ANCILRARY EQUIPMENT & WORK

The cost of items in this Section and other Sections of these specifications shall be equitably included in the appropriate Bid items.

204.1 Prior to disposal of any material or equipment that is Regional Metropolitan Utility Authority (Authority) property and removed as part of the contract work, Contractor shall contact the appropriate WWTP Plant Superintendent and explicitly offer to the Authority first right to claim and retain such materials or equipment as Authority property. Contractor shall be responsible for the disposal of all such equipment and materials not claimed by the Authority. Items identified for salvage shall be removed carefully, protected, palletized and delivered to the Haikey Creek WWTP Maintenance building. A copy of the Contractor's transmittal shall be provided to the Engineer after delivery.

204.2 Contractor shall field verify all elevations and dimensions of existing piping, valves, and equipment to be demolished. Contractor work shall be based on field measurements and shall include field adjustments and additions for the proper installation of equipment. The Contractor shall take note of all objects in the vicinity of equipment being installed to ensure that there are no issues with interference. It is the responsibility of the Contractor to make modifications necessary to adjacent objects such as pipe supports and similar to install the new equipment unless such objects are not reasonably visible during the site visit. It is the responsibility of the Contractor to review all field conditions and take necessary field measurements prior to ordering equipment. The Authority will make available the information it has pertaining to the existing equipment.

204.3 General Equipment Requirements:

204.3.1 Approved Equal Equipment: The manufacturers and models specified in the equipment specifications are considered pre-approved. The winning Contractor may, at their discretion, submit for approval equipment that has not been approved prior to the bid opening. When doing this, the Contractor should be aware that the submitted equipment must not only meet the performance requirements stated in the equipment specifications, but it also must meet or exceed the manufacturing, material, and quality specifications of the pre-approved equipment even though those specifications are not expressly listed in the section. The Engineer will review any non pre-approved equipment through the submittal process and compare it with the pre-approved equipment to
determine that the equipment is or is not equal. Contractor should be prepared to supply technical data, material information, standards conformance information, and other related information as requested by the Engineer. If the requested information is not supplied, the equipment will be deemed to be not equal. Approval of non pre-approved equipment will be at the sole discretion of the Engineer.

204.3.2 **Equipment Demolition:** All equipment shall be demolished in accordance with each bid item section. No existing equipment is to be abandoned in place unless specifically noted otherwise. All equipment being removed during demolition shall either be set aside for determination of surplus value or disposed of by the contractor per each bid item specification. If after removing the old equipment and installing the new equipment there are unused items still in place, it shall be the responsibility of the contractor to remove these items in a manner that will not affect adjacent equipment or systems. All removed electrical and fluid components shall be properly capped off at the point of removal. Removal shall be performed in a manner that will allow re-installation/replacement of the removed items at a later date if necessary.

204.3.3 **Gauges:** Each pump shall be provided with a combination pressure/vacuum gauge in the suction piping and a pressure gauge in the discharge piping. Gauges shall conform to ANSI/ASME B40.1 and shall be indicating dial type, with C-type phosphor bronze Bourdon tube and stainless steel rotary geared movement, or direct drive type with stainless steel helical-wound capillary tube pressure sensing element. The gauge shall have a phenolic open front turret case, and adjustable pointer, a stainless steel or phenolic ring, and an acrylic or shatterproof glass window. The dial shall be 4 ½ inches in diameter, with white background and black markings. Pointer travel shall span not less than 200 degrees or more than 270 degrees. All gauges shall be Accuracy Grade A or better. Pressure gauges shall read in pounds per square inch. Compound gauges shall read in inches of mercury vacuum and pounds per square inch. The range of each gauge shall be per pump manufacturer’s recommendation.

All gauges shall be installed with a diaphragm seal, brass flushing port and brass isolation valve of appropriate size.
204.3.4 **Mechanical Seals and Seal Water:**

204.3.4.1 All pumps shall be equipped with cartridge mounted double mechanical seals recommended by the pump manufacturer and compatible with Pump Seal Water Support Systems (PSWSS) installed at each pump. Refer to Construction Drawings and pump specifications for additional requirements.

204.3.4.2 The new seal water conditioning station (SWCS) and PSWSS may contain components that were not originally part of an existing seal water system. It is the responsibility of the contractor to supply and install all necessary electrical components including wiring, conduit, connectors, contactors, etc… for a complete installation of the new seal water system. It may also be necessary to integrate the new seal water system components into the existing equipment control system. The contractor shall be responsible for all labor and materials required to integrate new components into the existing control system. All electrical work on the seal water station shall conform to the General Electrical Requirements herein. Contractor shall demolish and remove all existing seal water components not reused in construction.

204.3.4.3 Seal water piping and accessories shall not utilize rigid PVC piping. Seal water lines connected directly to the mechanical seals shall be PEX. All other piping in the seal water station shall be of a non-corrosive metal material such as stainless steel, or painted copper. Valves and other components shall be bronze unless otherwise required.

204.3.4.4 Some existing pumps do not have mechanical seals. Contractor shall determine from field investigations the location of seal water for those pumps. It is the responsibility of the contractor to supply and install all seal water piping, electrical work and materials, and control work and materials required to add a seal water station where one was not used.
for existing equipment. Locations are to be approved by the engineer.

204.3.4.5 If a new pump is installed that does not require seal water and there are existing seal water lines at the pump location, it is the responsibility of the contractor to remove existing water lines. Lines shall be removed as far up stream as possible to a point that will not interfere with water supply to other equipment. No existing lines shall be abandoned in place.

204.3.5 Valves:

204.3.5.1 All valve parts and surfaces shall be of corrosion resistant materials or have a factory applied epoxy coating sufficient to prevent corrosion in a wastewater environment. See painting/coating section for coating thickness requirements.

204.3.5.2 Plug Valves and Check Valves: Plug valves and check valves shall be of the same size, style and construction as the units being replaced. It is the responsibility of the contractor to review the existing valves and provide correct similar units. Acceptable manufacturers are Pratt, DeZurik, Clow, Val-Matic, or an approved equal.

204.3.5.3 Butterfly Valves: Butterfly valves shall be of the same size, style, and construction as the units being replaced. It is the responsibility of the contractor to review the existing valves and provide correct similar units. Acceptable manufactures are DeZurik, Clow, Val-Matic, or an approved equal.

204.3.5.4 Gate Valves: Gate valves shall be of the same size, style and construction as the units being replaced. It is the responsibility of the contractor to review the existing valves and provide correct similar units. Acceptable manufacturers are Wey, DeZurik, or approved equal.

204.3.5.5 Plug and butterfly valves supplied with hand wheel operators that are installed more than 6’-0” above floor level shall be supplied with chain wheels and chains to allow for valve operation from the floor.
204.3.5.6 Valves and operators shall be selected by the contractor such that when installed in close proximity to one another the operators will be a sufficient distance apart to allow for uninhibited use by personnel.

204.3.6 Equipment Tagging: New equipment shall be tagged, according to the requirements listed below, with a permanent and visible tag showing the new equipment number using the City of Tulsa Equipment ID numbering system. All tags should be visible to anyone without the need to remove covers or otherwise “hunt” for the tag. See individual equipment sections for Equipment ID numbers for each item. Tags shall conform to the following specifications.

204.3.6.1 Requirements:

- Any equipment valued over $1,000
- All Valves greater than 8”
- All relief and motorized valves that are smaller than 8”
- Any equipment that requires preventive maintenance
- Any equipment that is critical to the process of the plant
- Any equipment that is considered a Safety item
- Emergency Eyewash/Showers
- Fire Extinguishers
- All Ladders
- Hoists
- Detectors
- Overhead Doors
- Fire Alarms/Sprinklers
- Emergency Lights

204.3.6.2 Equipment ID tag numbering shall meet the following requirements:
PRODUCTS

Equipment ID Number Plates

All equipment tagged on the drawings, except for buried submerged equipment shall be provided with an Equipment ID Number Plate bearing the equipment tag number identified on the drawings. Equipment ID Number Plates shall be rectangular 3.5” x .75” and 1/16” thick laminated blue phenolic plastic engraving stock that is U/V stable. Lettering shall be 1 line of text, centered, and white capitalized block letters .25” high and engraved to a depth of 0.08mm.

Equipment ID Number Plates must follow the Equipment ID numbering scheme. Each equipment or systems should also include an additional tag noting the general name of the equipment or system adjacent to the equipment ID numbering tag (ie “Final Clarifier #3”, VFD for Pump #2, etc).

Equipment ID Number Plates shall be attached with permanent adhesive.

Additional Number Plates shall be provided for ancillary devices associated with each piece of new tagged equipment. Additional tags shall be provided for all electrical disconnects, variable frequency drives and Motor Control Centers whether new or existing.

VALVE AND GATE EQUIPMENT ID NUMBER PLATES

Equipment Number Plates

All equipment tagged on the drawings, except for buried submerged equipment shall be provided with an Equipment Number Plate bearing the equipment tag number identified on the drawings. Equipment Number Plates shall be rectangular 3.5” x .75” and 1/16” thick laminated blue phenolic plastic engraving stock that is U/V stable. Lettering shall be 1 line of text, centered, and white capitalized block letters .25” high and engraved to a depth of 0.08mm.

Example: 1st line XXXX-
Equipment Number Plates must follow the equipment numbering scheme.

Equipment Number Plates shall be attached with permanent adhesive.

VALVE AND GATE EQUIPMENT NUMBER PLATES

Equipment Number Plates
All valves and gates, except buried or submerged valves, that have been assigned an equipment number on the Drawings or in the valve or gate schedule, shall be provided with a permanent number plate. Equipment Number Plates shall be round 1.5” and 1/16” thick laminated blue phenolic plastic engraving stock that is U/V stable. Lettering shall be in 3 sections, centered, and white capitalized block letters 3/16” high and engraved to a depth of 0.08mm.

Example: 1st line XXXX-
2nd line XXXX-
3rd line XXXXX

Equipment Number Plates must follow the equipment numbering scheme.

Equipment Number Plates shall be attached with permanent ties.

204.3.7 Equipment Coatings: All equipment shall be supplied with a factory applied coating sufficient to withstand a wastewater environment. Factory applied coating shall be in accordance with the painting/coating section.

204.3.8 Equipment Installation: All anchor bolt connections shall include the use of a washer, lock washer, and nut (without nylon or similar insert).
204.3.8.1 Installation of all equipment and related items shall be performed as directed in the manufacturer’s installation instructions.

204.3.8.2 No cutting, drilling or welding of new equipment or part thereof as delivered from the manufacturer for the purpose of adapting or modifying said unit to facilitate its installation will be permitted without written prior approval by the authority.

204.3.8.3 The Contractor shall be responsible for any and all concrete modifications that may be required to install the new equipment. This shall include modifications or replacement of equipment pads and supports. All modifications shall be designed and constructed to conform to the recommendations of ACI 302.1R-04 Guide for Concrete Floor and Slab Construction and ACI 301-10 Standard Specifications for Structural Concrete. All concrete modifications and repairs shall be coated per the painting/coating section herein.

204.3.9 Equipment Start Up and performance:

204.3.9.1 All new equipment installed by the contractor must be started up and be in operational service for 48 hours with no performance issues prior to demolishing and installing like, adjacent equipment in the same system. If the new equipment exhibits any performance issues, the contractor shall repair the equipment/installation as required and begin a new 48 hour observation period.

END OF SECTION
204.4 General Electrical Requirements

204.4.1 Electric Code Compliance: All electrical work shall be performed in compliance with current electrical code.

204.4.2 Electrical Disconnects: All equipment installed or worked on with an electrical portion in the scope of work shall have a new local disconnect switch installed. All local disconnect switches shall be of stainless steel construction meeting NEMA 4X standards. In the event a Class 1, Division 1 rating is required for explosion proof service, the disconnect shall meet all required ratings for Class 1, Division 1 service. Control panels that incorporate an integral disconnect will not be required to have an external disconnect.

204.4.3 Electric Motors: All electric motors shall be premium efficiency, suitable for operating the intended equipment per the equipment manufacturer’s recommendations.

204.4.4 Electrical Wiring & Related Items: Contractor shall use caution to avoid damage to existing power cables. These cables shall be reused in new equipment installation provided their reuse meets current code requirements. Contractor shall be responsible for any damage to existing electrical equipment or power cables. The contractor shall be responsible for removing the existing control system and replacing it with the new control system. No unused remnants of the existing control system shall be abandoned in place.

204.4.5 Identification: Conduits in manholes, hand-holes, building entrance pull boxes, junction boxes and equipment shall be provided with identification tags. Identification tags shall be 19 gage stainless steel with ½ inch stamped letters and numbers as indicated on the drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

204.4.6 Rigid Steel Conduit shall be heavy wall, plated/hot-dip galvanized, shall conform to ANSI C80.1, and shall be manufactured in accordance with UL 6. Not applicable to this contract unless specifically noted otherwise.

204.4.7 Liquid tight Flexible Metal Conduit shall be hot-dip galvanized steel, shall be covered with a moisture proof polyvinyl chloride jacket, and shall be UL labeled. For interior applications only.

204.4.8 Rigid Nonmetallic (PVC) Conduit - PVC conduit shall be heavy wall, Schedule 40, UL labeled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL651. Not acceptable and not applicable to this contract.
204.4.9 Aluminum Rigid Conduit system:

204.4.9.1 The conduit shall be rigid aluminum, threaded, T-1 temper as part of electrical of an all-aluminum conduit system with couplings, bends and fittings as required. Any fasteners and other hardware shall be 316 stainless steel as required and applicable. In the event a Class 1, Division 1 rating is required for explosion proof service, the conduit system shall meet all required ratings for Class 1, Division 1 service. Provide in all interior and exterior installation locations.

204.4.9.2 The conduit system shall be UL 6A and ANSI C80 5 rated for application.

204.4.9.3 Provide “seal-off” corrosion protection at all and panels, device outlets and equipment as recommended by conduit Manufacture.

204.4.9.4 Acceptable manufactures are Wheatland Tube, Republic Conduit, and American Conduit by Sapa or equal.

204.4.9.5 Unless a Manufacture requirements, code or other governing requirement specifically require something other than aluminum conduits, all conduits and accessories shall be aluminum

204.4.10 Conductors. All conductors in power, control and instrumentation circuits shall be identified and color coded as described herein.

204.4.10.1 Conductor Identification Number. Except for lighting and receptacle circuits, each individual conductor in power, control and instrumentation circuits shall be provided with wire identification markers at the point of termination.

204.4.10.2 The wire numbers shall be of the heat-shrinkable tube type, with custom typed identification numbers.

204.4.10.3 The wire numbers shall be as indicated on the equipment manufacturer’s drawings.

204.4.10.4 The wire markers shall be positioned to be readily visible for inspection.

204.4.11 Conductor Color Coding. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking
tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.

204.4.11.1 The following color coding system shall be used for Power conductors:

204.4.11.1.1 120/240V, single-phase – black, red and white
204.4.11.1.2 120/208V, three-phase – black, red, blue and white
204.4.11.1.3 120/240V, three-phase – black, orange, blue and white
204.4.11.1.4 277/480V, three-phase – brown, orange, yellow and gray
204.4.11.1.5 Where 120/240 and 120/208 volt system share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.

204.4.11.2 Control and instrumentation circuit conductors shall be color coded as indicated below:

204.4.11.2.1 Multiconductor Control Cable: 600 Volt Multiconductor 14 AWG Control Cable
204.4.11.2.2 REFERENCE: UL 83, UL 1277, ICEA S-73-532, ICEA S-58-679.
204.4.11.2.3 CONDUCTOR: 14 AWG, 7 OR 19 strands, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.
204.4.11.2.4 INSULATION: Polyvinyl chloride, not less than 15 mils average thickness;13 mils minimum thickness, UL 83 Type THHN and THWN.
204.4.11.2.5 SHIELD: None.
204.4.11.2.6 JACKET: Conductor: Nylon, 4 mils minimum thickness, UL 83.
204.4.11.2.7 Cable assembly: Black, flame-retardant polyvinyl, UL 1277, applied over tape-wrapped cable core.
204.4.11.2.8 COLOR IDENTIFICATION: ICEA S-58-679, Method 1, Table 2 or ICEA S-58-679, Method 3, Table 2. White or green conductors shall not be provided. A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches. Marking shall include manufacturer's name, Type THWN or THHN, conductor size, number of conductors, and voltage class.

204.4.12 Signal Control Cable:

204.4.12.1 REFERENCE: UL 62, UL 1277.

204.4.12.2 CONDUCTOR: 16 AWG, 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

204.4.12.3 INSULATION: Polyvinyl Chloride, not less than 15 mils average thickness: 13 mils minimum thickness, UL 62, Type TFN.

204.4.12.4 LAY: Twisted pair with 1-1/2 inch to 2-1/2 inch lay.

204.4.12.5 SHIELD: Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulation conductors.

204.4.12.6 JACKET: Conductor. Nylon, 4 mils minimum thickness, UL 62.

204.4.12.7 Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

204.4.12.8 CONDUCTOR IDENTIFICATION: One conductor black, one conductor white.

204.4.13 Single Conductors: 600 Volt, Single Conductor Power Cable

204.4.13.1 REFERENCE: UL 83, ICEA S-95-658 (NEMA WC 70).

204.4.13.2 CONDUCTOR: Stranded, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.
204.4.13.3 INSULATION: Polyvinyl, UL 83, type THHN and THWN, ICEA S-95-658.

204.4.13.4 SHIELD: None

204.4.13.5 JACKET: Conductor. Nylon, 4 mils minimum thickness, UL 83.

204.4.14 Pump Control Panels (Cabinets) – Unless otherwise noted, Contractor shall provide each unit with the following system components to conform to the following specifications:

204.4.14.1 Input Disconnect: Furnish an input circuit breaker with an interrupting rating of 65,000 rms symmetrical amperes.

204.4.14.2 Control Devices: Include door mounted control and monitoring devices for each sump pump as follows:

A. "Manual-OFF-Auto" control selection
B. Power disconnect
C. Elapsed time meter; shall be non-resettable, rollover at 9999 hours showing resolution of 0.1 hours
D. Phase loss monitor
E. Indicator lamps for Power On, Run, Phase Loss and Overload.

204.4.14.3 NEMA contactors size 1 or larger rated to handle the connected load.

204.4.14.4 Refer to Drawings for control panel schematics for additional requirements.

204.4.14.4 Coil Voltage: 120-volts, 60-hertz.

204.4.15 Variable Frequency Drives (VFD):

204.4.15.1 Enclosures: New VFD units shall be supplied with and installed in a new enclosure. All component enclosures shall be NEMA 12 compliant, and shall fit in the location of replaced equipment.
204.4.15.2 System Features: Contractor shall provide each unit with the following system components to conform to the following specifications:

204.4.15.3 Input Disconnect: Furnish an input circuit breaker with an interrupting rating of 65,000 rms symmetrical amperes.

204.4.15.4 The VFD units must comply with all requirements of the existing pumps. The new VFD units shall be 18 pulse "clean power", low harmonic in compliance with IEEE 519 guidelines for harmonic mitigation and have a continuous output current of approximately 30% more than the motor full load nameplate current.

204.4.15.5 New VFD units shall be installed with no cutting, drilling or welding of the new equipment or part thereof as delivered from the manufacturer, for the purpose of adapting or modifying said unit to facilitate its installation, will be permitted without written prior approval by the Authority.

204.4.15.6 Control Devices: Include door mounted control and monitoring devices for each drive as follows:

- Start push button
- Stop push button
- "Local-OFF-Remote" control selection
- Maintained Emergency shutdown button – Palm press and red in color
- Speed selection – Door mounted potentiometer operating single turn 0% - 100%
- Frequency meter with hertz and 0-100 scales
- Output ammeter
- Elapsed time meter shall be non-resettable, rollover at 9999 hours showing resolution of 0.1 hours.
Diagnostic package with fault indication and reset push button

Indicator lamps for the ON, OFF, Auto, Vibration and FAULT unit status conditions

Vibration sensors shall be installed and operated such that when a vibration alarm is triggered, the VFD/Pump shuts down automatically

Vibration sensors shall have the operating capacity of sending a 4-20 mA signal to an analog PLC input and a dry set of contacts for the relay logic

204.4.15.7 PLC Control Features: Furnish a control system for each drive to allow the following Auto/PLC functions:

- Remote, isolated 4-20 mA speed control input
- Isolated 4-20 mA speed output
- PLC Remote Run command
- Alarm outputs
- ON/OFF status output
- Additional features and controls specified with the drive equipment
- Local/Auto status output

204.4.15.8 New and replacement VFDs shall be installed such that all 4-20mA features are available. If a VFD being replaced is not currently configured to communicate with the SCADA system, the replacement unit shall communicate with the SCADA system in the same manner of a new VFD installation. On new VFD installations, all 4-20mA communication features shall be installed in the VFD for future connection to the SCADA system
204.4.15.9 General Purpose Contactors: Provide general purpose contactors in accordance with NEMA ICS 2 meeting the following:

Coil Voltage: 120-volts, 60-hertz

Poles: Provide three-pole contactors, unless otherwise indicated.

204.4.15.10 Electrical Wiring: Contractor shall be responsible for verifying or replacing all wiring from existing breakers and/or disconnects to the new equipment including replacing breakers as required. All wiring and electrical construction shall meet current electrical code.

204.4.15.11 Complete O&M Manuals and operating parameters shall be supplied on CD.

204.4.15.12 Electrical Wiring & Related Items:

204.4.15.13 All wire to wire connections shall be made using insulated mechanical connectors. All shielded cable shall use heat shrink to cover cable outer cover and shield for termination. No wire nuts or butt splices are to be used unless previous authorization is given by the engineer. Insulated mechanical connectors shall be manufactured by Penn-Union, Galvan Industries, Polaris Electrical Connectors, or an approved equal manufacturer.

204.4.15.14 Power and control wiring will follow the NFPA 79 Chapter 13 standard.

204.4.15.15 Control wiring labeling shall follow NFPA 79 Chapter 13 standard. Control wiring identification tags shall be a thermal transfer print. A Brady TLS2200 or equivalent.

END OF SECTION
204.5 Equipment Painting/Coating

204.5.1 Surface Preparation and Shop Prime Painting: All equipment and disturbed surfaces shall be cleaned and shop primed per equipment manufacturer’s recommendation as part of the work. Equipment nameplates and similar information tags shall be masked off for removal after finish coat applications. All surface preparation for applying a specified coating system shall be done in accordance with the appropriate “Application Bulletin” from the manufacturer for the specific product specified. Provide minimum SP-10 Near white blasting unless Manufacture requirements are more stringent. Equipment vendors/manufacturers shall be consulted concerning the required final coating system to ensure that it will be compatible with the primer coat applied at the factory, in the event that the shop applied primer coat is not removed prior to the coating installation.

204.5.2 Final Coat: Unless otherwise specified, all new equipment shall be shop or field painted with a final coat, provided all shop painted finish surfaces shall receive matching field touch-up painting as final treatment, all with a finish coat per the equipment manufacturer’s recommendation. All disturbed surfaces shall be field painted after equipment installation with a finish coat per the equipment manufacturer’s recommendation.

204.5.2.1 Disturbed surfaces will be defined as including piping between suction and discharge valves on pump assembly replacements and pipe to either side of valves on individual valve replacements. All other disturbed surfaces will be defined as existing materials adjacent to new equipment.

204.5.3 Coating Systems

204.5.3.1 The Coating System for painting structural steel, piping, valves, etc. not exposed to sunlight shall be Sherwin-Williams Coating System Identification A-1, Alkyd 2-coat system. This system has a primer “KemKromik, Univ. Primer” and a finish coat “Industrial Urethane, Alkyd Enamel” or an approved equal. Contractor shall submit supplier information for approval prior to painting.
204.5.3.2 The Coating System for painting structural steel, piping, valves, etc. non-immersed, mildly corrosive, wet environments and not exposed to sunlight shall be Sherwin-Williams Coating System Identification E-1, Polymide Epoxy system. This system has a primer "Macropoxy 646" and a finish coat "Macropoxy 646" or an approved equal. Contractor shall submit supplier information for approval prior to painting.

204.5.3.3 The Coating System for painting metal surface for exterior weathering exposure in a corrosive environment shall be Sherwin-Williams Coating System Identification EU-2, Urethane Finish, Corrosive Areas 3-coat system or equal. This system has a primer "Corothane Galvapac", second coat "Macropoxy 646" and a finish coat "Hi-solids Polyurethane" or an approved equal. Contractor shall submit supplier information for approval prior to painting.

204.5.3.4 Coating System for painting metal surface for full or partial immersion service shall be Sherwin-Williams Coating System Identification E-3, Amine Epoxy Glass Flake Reinforcement or equal. This is a two-coat system using Sher-Glass Epoxy FF. The first coat shall have a red oxide color with a minimum dry film thickness of 10-15 mils. The second coat shall have a haze gray color. Total dry film thickness shall be a minimum 20-25 mils. Application and total dry film thicknesses shall be installed per Manufacturer's recommendations.

204.5.3.5 Paint color code shall adhere strictly to DEQ code requirements. Paint Color Schedule (All colors and codes are Sherwin Williams. A crossover for Tnemec and Carboline is available on request.):

a. Potable WaterFlyway SW6794
b. Plant Effluent Water (PEW) Blueblood SW6966 w/ Orange bands
c. Chilled Water French Roast SW6069 w/ Hearthrob SW6866 bands
d. Heating Water Supply Gray Screen SW7071 w/ White bands
e. Heating Water Return  Gray Screen SW7071 w/ Black bands

f. Compressed Air  Supreme Green W6442

g. Instrument Air  Supreme Green SW6442

h. Blower Air  Supreme Green SW6442

i. Natural Gas  Hearthrohb SW6866

j. Sludge Return  Bagel SW6114

k. Sludge Waste  Sensational Sand SW6094

l. Digested Sludge  French Roast SW6069

m. Sludge Sample  Web Gray SW7075 w/ Hearthrohb SW6866 bands

n. Drain/Sump  Web Gray SW7075

o. Raw Sewage  Software SW7074

204.5.3.5.1 If the equipment or piping being painted does not fall under any of these categories, the contractor shall make the best color match to the materials being replaced and adjacent like materials. Submit color selection for acceptance.

204.5.3.6 After painting, any labeling or tags covered by the paint shall be re-applied, updated or uncovered such that all labels are readable and clearly identifies the system. In the event of new piping or equipment replacing piping or equipment with labeling, the new equipment shall be labeled to match the existing. Marking and signage shall be applied once area painting is complete as part of the schedule of value item.

204.5.3.7 Equipment supplied from the manufacturer with an epoxy coating or manufactured from a corrosion resistant material (stainless steel, etc…) shall not be painted/coated after installation.
204.5.3.8 Factory applied epoxy coating systems shall be in the following thicknesses unless noted otherwise per Manufacturer’s recommendations:

a. Primer Coat 3.0 to 5.0 mils
b. Finish Coat 4.0 to 6.0 mils

204.6 Concrete Coating

204.6.1 Materials: Concrete coating shall be Sikagard 62, Raven 405, Sauereisen SewerGard No. 210, or an approved equal to protect concrete and concrete repairs from H$_2$S and other corrosive elements found in wastewater process facilities. Epoxy coating to be applied according manufacturer’s installation instructions and shall extend beyond repair areas by a minimum of 6”. All concrete coating products shall be handled and stored in the manner set forth in the manufacturer’s installation instructions.

204.6.2 Surface Preparation: Concrete surfaces to receive coating shall be inspected prior to surface preparation to determine the condition of the surfaces specified to receive the coating product(s) and the appropriate method or combination of methods to be used for surface preparation to meet the requirements of the coating system(s) to be applied per manufacturer’s instructions.

204.6.2.1 Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed per ASTM D-4258.

204.6.2.2 Efforts shall be made to minimize the change of holidays and coating thin areas by this contract. Concrete fins, protrusions, burrs, sharp edges and concrete spatter shall be corrected by grinding or scraping. Concrete bug holes and other small voids shall be filled with a non-shrink grout limited to each hole or void. A full grout rub of the wall is not allowed unless specifically approved by the Engineer.
204.6.2.3 Unless otherwise submitted and approved by the Engineer, surfaces to receive coating shall be abrasive blasted per ASTM D-4259 to remove laitance and weak concrete to expose subsurface voids, open honeycomb and air pockets. After blasting, surfaces shall be cleaned of all loose blast grit, dust and other debris by sweeping, vacuuming, air blasting and washing as necessary.

204.6.2.4 Surface preparation method(s) used shall be performed in a manner that provides a uniform, sound clean neutralized surface suitable for the specified coating product(s).

204.6.2.5 Infiltration shall be stopped by using a material which is compatible with the repair products and is suitable for top coating with the coating product(s).

204.6.2.6 Where defective concrete is encountered requiring repair at the direction of the Engineer refer to Specification Section 204.7 Concrete Rehabilitation for requirements.

204.6.3 Application of coating products: Application procedures shall conform to the recommendations of the coating product(s) manufacturer, including environmental controls, product handling, mixing, application equipment and methods.

204.6.3.1 Prepared surfaces shall be primed by application of the waterborne epoxy primer described herein at an application rate of 200 square feet per gallon (8 mils wet film thickness). The primer shall be allowed to dry to a tack free state. The solvent-free epoxy topcoat described herein shall then be spray applied to a minimum wet film thickness of 80-100 mils.

204.6.3.2 No more than 12 hours shall be permitted to pass between each application of the waterborne epoxy, the solvent-free epoxy primer and the epoxy topcoat. Subsequent top coating or additional coats of the coating product(s) shall occur within the products recoat window as adjusted for temperature extremes. Additional surface
preparation procedures will be required if this recoat window is exceeded.

204.6.3.3 Coating product(s) shall interface with adjoining construction materials throughout the structure to effectively seal and protect concrete substrates from infiltration and attack by corrosive elements. Procedures and materials necessary to effect this interface shall be as recommended by the coating product(s) manufacturer.

204.6.4 Submittals: The Contractor shall submit the following to the Engineer, in accordance with this Specification:

- Product data sheets and installation procedures for proposed concrete repair mortar(s).
- Detailed design notes, calculations and Shop Drawings for any temporary works, including formwork and falsework.

204.7 Concrete Rehabilitation

204.7.1 Description: The Work shall consist of:

- Removing the deteriorated concrete as shown and described on the Drawings and in this Specification, including saw cutting the perimeter of the repair area.
- Preparing the surface of the concrete for the repair, including abrasive cleaning, cleaning of existing reinforcement, and applying bonding agent to the surface.
- Supplying materials and the mixing and placing of concrete repair mortar or concrete as shown and described on the Drawings and in this Specification including vibrating, finishing and curing.
- Supplying, fabricating, constructing, maintaining and removing temporary works, including falsework and formwork.
204.7.2 **Submittals:** The Contractor shall submit the following to the Engineer, in accordance with this Specification:

- Product data sheets and installation procedures for proposed concrete repair mortar(s).
- Detailed design notes, calculations and Shop Drawings for any temporary works, including formwork and falsework.

204.7.3 **Materials:** The Contractor shall supply all materials necessary for the repair and restoration of deteriorated concrete areas as follows:

204.7.3.1 **Acceptable Manufacturers:**

a. Sika MonoTop 611, as manufactured by Sika Corporation, Lyndhurst, New Jersey, and Quadex QM-1s Restore, as manufactured by Quadex, North Little Rock Arkansas, are considered to conform to the requirements of this specification and has performed satisfactorily for patching or overlaying for a minimum of three years.

b. Substitutions: The use of other than the specified product will be considered providing the contractor requests its use in writing to the Engineer. This request shall be accompanied by:

- A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds the specified performance criteria, tested in accordance with the specified test standards; and
- Documented proof that the proposed substitute product has a three year proven record of performance of patching or overlaying, confirmed by actual field tests and five successful installations that the Engineer can investigate.
Certification from the manufacturer demonstrating compliance with the ISO 9000 quality standard in the development, manufacture, and sale of the product.

204.7.3.2 Performance Criteria Typical Technical Data

a. Typical Properties of the mixed polymer-modified portland cement mortar:
   - Working Time: approximately 30 minutes
   - Finishing Time: 30-60 minutes
   - Color: concrete gray

b. Typical Properties of the cured polymer-modified portland cement mortar:
   - Compressive Strength (ASTM C-109)
     - 1 day: 3,000 psi
     - 7 day: 5,500 psi
     - 28 day: 6,500 psi
   - Splitting Tensile Strength (ASTM C-496) at 28 days: 500 psi
   - Flexural Strength (Modulus of Rupture)(ASTM C-78) at 28 days: 720 psi
   - Bond Strength (ASTM C-882 Modified) at 28 days: 2200 psi
   - Chloride ion permeability (AASHTO T-277): < 600 coulombs
   - The silica fume, polymer-modified portland cement mortar shall not produce a vapor barrier.

204.7.3.3 Materials

a. Silica-fume, Polymer-modified portland cement mortar:
   - The mortar shall be a silica fume-enhanced, polymer-modified composition containing a blend of selected cements, plasticizing/water-reducing admixtures and shrinkage compensating agents.
   - The material shall be non-combustible, either before or after cure.
- The silica fume, polymer-modified portland cement mortar shall be supplied in a factory proportioned unit.
- The silica fume, polymer-modified portland cement mortar must be placeable from 3 inches in depth and extendable in greater depths.

b. To prepare the silica fume, polymer-modified portland cement concrete (for pumping): the factory proportioned unit may be extended with 34-36 lbs. of a minus 1/4 in. clean, well-graded, saturated surface dry aggregate, having low absorption and high density. Aggregate shall conform to ASTM C-33.

c. Materials for forming, as required for the designated work, shall be approved by the Engineer.

204.7.4 Construction Methods

204.7.4.1 Surface Preparation Prior to any concrete repairs, the Contractor shall remove all dust, dirt, water and debris from the surface of the concrete in a manner that will not result in the material being deposited into the channel or onto the underlying ground surface below. The Contractor shall supply and erect appropriate protection barriers/shrouding or other approved means as required on the bridge deck or piers so as to completely contain all loose or flying debris from the surface removal preparations. The means of containment shall be subject to the approval of the Engineer. No debris shall fall into the channel or onto any underlying roadway or ground surfaces.

204.7.4.2 Concrete Removal All areas of unsound concrete to be repaired will be marked by the Engineer once the Contractor has cleaned the existing surface as per Section 204.6.2 of this Specification. The Contractor shall saw cut the outer perimeter of the repair areas 1” deep or as directed by the Engineer. Feathered edges will not be acceptable. The Contractor shall take care to ensure that the existing reinforcing steel or prestressing strands (if applicable) are not damaged during saw cutting. Any damage caused by the Contractor
to any portion of the structure not intended for repair shall be repaired by the Contractor, at the Contractor’s expense, to the satisfaction of the Engineer. The Contractor shall remove all areas of unsound concrete by chipping or other approved methods. Only chipping hammers of the 20 lb class or less shall be used, and operated at an angle of 45 degrees or less from the horizontal. The Contractor shall exercise caution and take care not to damage any existing reinforcing steel intended to remain in place.

204.7.4.3 Types of Repairs Concrete repairs will be classified as follows:

a. Type A Partial Depth Concrete Repair – A Type A repair is defined as removal of unsound concrete to a depth not greater than the top of the existing reinforcing steel. The Contractor shall remove all unsound concrete from the areas as determined by the Engineer until a sound concrete substrate is exposed.

b. Type B Partial Depth Concrete Repair – A Type B repair shall be defined as removal of unsound concrete to a depth a minimum of 1” beyond the existing outer mat of reinforcing steel. For substructure, girder or mass concrete repairs the maximum depth shall be 2” beyond the existing outer mat of reinforcing steel or as directed by the Engineer. For slab repairs the maximum depth shall be mid depth of the slab.

204.7.4.4 The Contractor shall supply and place additional reinforcing steel as directed by the Engineer when the existing reinforcing steel has a section loss of 25% or greater. The reinforcing steel shall be of the same type and size as the existing, and spliced with a minimum lap length of 30 bar diameters. Exposed reinforcing steel shall be sandblasted clean and maintained to a near white condition. The Contractor shall roughen all areas of the existing sound concrete substrate to a ¼” amplitude using methods acceptable to the Engineer. All resulting material and by-products from demolition operations shall be collected, loaded, hauled, and disposed of by the Contractor at an approved waste disposal facility. Costs for
reinforcing steel shall be considered incidental and included in other portions of the work.

204.7.4.5 Surface Preparation Immediately prior to placing the repair mortar or concrete, the Contractor shall thoroughly clean the existing concrete surfaces and formed repair areas, and apply a low resistivity bonding agent or cement slurry as recommended by the repair mortar manufacturer or as directed by the Engineer.

204.7.4.6 Repair Mortar Placement and Finishing The concrete repair mortar shall be handled, stored, mixed and applied in accordance with the manufacturer’s instructions. Immediately prior to placing the repair mortar, the Contractor shall thoroughly clean the existing concrete surfaces and formed repair areas, and apply a low resistivity bonding agent or cement slurry as recommended by the repair mortar manufacturer or as directed by the Engineer. The Contractor shall place the repair mortar such that the existing profile and cross section are restored to their original dimensions. Any deviations of \( \frac{1}{4}'' \) or greater from the repaired areas to the existing surface shall be repaired by the Contractor at his expense to the satisfaction of the Engineer. If the existing or repair concrete surface is damaged in any way by construction operations, or if the concrete repair shows signs of distress or scaling prior to final acceptance, it shall be repaired or replaced by the Contractor at his own expense. The Contractor shall finish the repair surface in accordance with the concrete coating manufacturer’s requirements.

204.7.4.7 Curing shall be in accordance with the manufacturer’s instructions or as otherwise directed by the Engineer.

204.7.5 Quality Management

204.7.5.1 General Concrete repair mortar that is not stored, handled, prepared, placed, or cured in accordance with the manufacturer’s instructions will be rejected by the Engineer and his/her decision shall be considered final. The Engineer reserves the right to require
immediate removal of any concrete from rejected batches that may have already been placed in the structure. Quality assurance testing will be carried out by the Engineer and all associated costs will be paid for by the Owner. There shall be no charge to the Owner for materials taken by the Engineer for testing purposes.

204.7.6 Method of Measurement

204.7.6.1 Concrete Repairs  Concrete repairs will be measured on a surface area basis. The area to be paid for will be the total number of square feet of concrete repaired in accordance with this specification as computed from measurements made by the Engineer.

204.7.7 Basis of Payment

2.4.7.7.1 Type A Partial Depth Concrete Repair – Type A Partial depth concrete repairs will be paid for at the Contract Unit Price per square foot for “Type A Partial Depth Concrete Repair”, measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

204.7.7.2 Type B Partial Depth Concrete Repair – Type B Partial depth concrete repairs will be paid for at the Contract Unit Price per square foot for “Type B Partial Depth Concrete Repair”, measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

END OF SECTION
204.8 GENERAL

204.8.1 STANDARDS

204.8.1.1 Concrete work shall conform to all requirements of ACI 301-89 "Specifications for Structural Concrete for Buildings", ACI 350 "Code Requirements for Environmental Engineering Concrete Structures", ACI 318-89 "Building Code Requirements for Reinforced Concrete" except as modified herein.

204.8.1.2 All referenced standards shall be the latest editions.

204.8.2 SCOPE

204.8.2.1 Work consists of furnishing all plant, labor, materials, equipment and appliances, and performing all operations in connection with installation of the concrete work, complete, in strict accordance with the Specifications and Drawings.

204.8.3 INSPECTION

204.8.3.1 Embedded items must be inspected and tests for concrete and other materials shall have been completed and approved by the Engineer before concrete is placed.

204.8.4 SLAB ON EARTH

204.8.4.1 Before proceeding to construct concrete slabs on earth, all pipes under concrete floor on earth shall have received the required tests. All backfill and fill material under slabs on grade shall be compacted in 6" layers to 95% maximum density as measured by AASHTO T99 test method. Unsuitable material encountered in subgrade shall be removed and replaced with material approved by the Engineer. Subgrade shall be brought to true, even plane and compacted to solid bearing. Gravel drainage fill shall be placed and compacted where shown on Drawings.

204.8.5 MATERIALS

204.8.5.1 All concrete materials shall conform to the latest revised ASTM Designations.
listed below and shall be subject to the approval of the Engineer:

204.8.5.1.1 Coarse Aggregate shall be crushed stone conforming to ASTM C-33 with a maximum size of 1".

204.8.5.1.2 Fine Aggregate shall conform to ASTM C-33 and shall be washed river sand composed of clean, uncoated grains of strong materials.

204.8.5.1.3 Cement shall be Portland cement conforming to ASTM Specification C-150, Type V. Only one brand of cement shall be used for exposed concrete.

204.8.5.1.4 Water: Clean, fresh and free from oil, acids, alkali, vegetable, sewage, organic or other deleterious matter.

204.8.5.1.5 Air-Entraining Admixtures shall conform to ASTM C-260.

204.8.5.1.6 Premolded Expansion Joint Filler Strips shall be non-extruding type conforming to the current AASHTO Designation M213.

204.8.5.1.7 Non-Shrink Grout shall be Pre-mixed "Embeco" as manufactured by Master Builder's, "Ferrolith G" as manufactured by Sonneborn-Contech, or approved equal. Type as recommended by the manufacturer for the particular applications.

204.8.5.1.8 Liquid Curing Compound/Sealer shall be "MC 429" as manufactured by Master Builder's, "Kure-N-Seal" as manufactured by Sonneborn-Contech, "Thompson's Water Seal" as manufactured by E. A. Thompson, Inc. or approved equal.

204.8.5.1.9 Granular Drainage Fill: Required under all interior building concrete slabs on grade and where noted on the drawings. It shall be either:

204.8.5.1.9.1 Clean, washed gravel with particle sizes grading from maximum of 1" down to not more than 5% passing a No. 4 sieve.
204.8.5.1.9.2 Clean, washed coarse sand with particular sizes ranging from pea gravel down to largest grains permitted in concrete sand.

204.8.5.1.10 Joint Waterproofing for existing structures or as required on the plans shall be Ironite (Metallic) Waterproofing as manufactured by the Ironite Company of Chicago, Illinois or approved equal.

204.8.5.1.11 Vapor Barrier required under all interior concrete slabs on grade and where noted in drawings shall be polyethylene sheet, 6 mil thickness conforming to ASTM E-154.

204.8.5.1.12 Liquid Chemical Hardener shall be the magnesium fluosilicate and zinc fluosilicate type "Lapidolith" as manufactured by Sonneborn-Contech, Inc., "Symons Quad Cure" as manufactured by Symons Corp., "Hornolith" as manufactured by W. R. Grace & Co., or approved equal.

204.8.5.1.13 Cementitious Waterproofing and Finish Compound shall be "Thoroseal Plaster Mix" with "Acryl 60" as manufactured by Standard Dry Wall Products or equal.

204.8.6 QUALITY AND CONTROL

204.8.6.1 Design - Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate and water. All concrete shall be designed by an independent testing laboratory, approved by the Engineer, in accordance with the A.C.I. Standard "Recommended Practice for Selecting Proportions for Concrete" (ACI 211) to produce the strength for each class of concrete specified, and with slumps and maximum sizes of coarse aggregate in accordance with the requirements outlined below. The concrete shall be so designed that the concrete materials will not segregate and excessive bleeding will not occur. Submit laboratory trial mix designs and test results for each class of concrete to be used to the Engineer for approval before any concrete is placed. Any costs of the testing laboratory for designing concrete mixes shall be borne by the Contractor. Concrete strengths shall be as follows:
Class A Concrete - 4000 psi minimum @ 28 days (Air entrained) - six (6) sacks cement minimum

Class B Concrete - 3000 psi @ 28 days - five (5) sacks cement minimum

Class C Concrete - 2000 psi @ 28 days

Class D Concrete - 3000 psi @ 28 days (3/8" Max. Aggregate Size "Pea Gravel")

MAXIMUM SLUMPS FOR VARIOUS TYPES OF CONSTRUCTION

<table>
<thead>
<tr>
<th>Types of Construction</th>
<th>Hand Placed Maximum</th>
<th>High Frequency Vibrator Used - Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced Foundation, Footings and Base Slabs of Tanks</td>
<td>5&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Slabs, Beams and Reinforced Walls</td>
<td>6&quot;</td>
<td>5&quot;</td>
</tr>
<tr>
<td>Building Columns</td>
<td>6&quot;</td>
<td>5&quot;</td>
</tr>
<tr>
<td>Pavements, curb and sidewalks</td>
<td>3&quot;</td>
<td>3&quot;</td>
</tr>
</tbody>
</table>

The slump shall not exceed the maximum specified above for the type of construction for which it is to be used. The 28 day compressive strength determined in accordance with current ASTM Specifications C-39 and C-31 and with specimens cured in accordance with C-31 shall not be less than that shown above for the specified class of concrete. No water will be added after the amount specified by the mix design.

204.8.6.2 Production of Concrete

All ready-mix concrete shall be batched, mixed and transported in accordance with "Specifications for Ready-Mixed Concrete (ASTM C-94)". Plant equipment and facilities shall conform to the "Check List for Certification of Ready-Mixed Concrete Production Facilities" of the National Ready-Mixed Concrete Association. Site mixed concrete shall conform to the requirements of "Specifications for Structural Concrete" (ACI 301). The Contractor may elect to use either ready-mixed or site mixed concrete for this project provided he informs
the Engineer of his choice.

204.8.3.3 Laboratory Testing

The **Owner shall engage an independent testing laboratory** to conduct concrete tests. Contractor will be responsible for sampling concrete for test cylinders, recording, and delivering them to the laboratory, providing all materials required, and for making all slump tests in the field directed by the Engineer. All costs in connection with work performed by the laboratory will be paid by the Owner. The Contractor shall be responsible for the costs of work performed by the laboratory required for redesign of concrete proportions and additional testing of in place concrete when cylinders indicate low strength concrete has occurred.

At least one test shall be made on fresh concrete for each one hundred (100) cu. yds. of each class of concrete (or fraction thereof) placed on any one day and in any event, not less than one test for each class of concrete each day it is used. Testing shall be done in accordance with the following ASTM Specifications, latest edition:

- C172- Standard Method of Sampling Fresh Concrete
- C31 - Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field
- C39 - Standard Method of Test of Compressive Strength of Molded Concrete Cylinders
- C143- Standard Method of Slump Test for Consistency of Portland Cement Concrete

Before any concrete is poured, the Contractor shall construct a storage box in accordance with ASTM Specification C31. Each set of tests shall consist of one slump test and four compression test cylinders. All cylinders shall be kept in the storage box for the first 24 hours. The four cylinders shall be laboratory cured and tested for adequacy of the design for strength of the concrete in accordance with ASTM Specification C31. One cylinder shall be tested at 7 days and two at 28 days.
The fourth cylinder will be retained for subsequent testing if required by the Engineer.

204.8.3.4 Failure of Concrete to Meet Strength Requirements: The concrete shall be considered acceptable if, for any one class of concrete, the average of all tests of any five consecutive sets is equal to or greater than the specified strength, provided that no more than one test in ten falls between 90% and 100% of the specified strength. The only cylinders to be used for determination of concrete acceptability will be those laboratory cured and tested at 28 days. When it appears the tests of laboratory-cured cylinders will fail to meet these requirements, the Engineer may require changes in the proportions of concrete for the remainder of the work in order to meet the strength requirements. In addition, the Engineer may also require additional curing on portions of the concrete already poured.

The Engineer may also require tests in accordance with Methods of Securing, Preparing and Testing Specimen from Hardened Concrete for Compressive and Flexural Strengths (ASTM Specifications C42) when the concrete cylinder tests fail to meet strength requirements. In the event there still is question as to the quality of the concrete in the structure, the Engineer may require load tests for that portion where the questionable concrete has been placed. Such load tests will be made as outlined in American Concrete Institute Building Code, (ACI 318), and shall be at the expense of the Contractor. In-place testing shall be at the expense of the Contractor.

204.8.3.5 Removal of Under Strength Concrete: If the above tests indicate that a particular batch of previously placed concrete is under strength, the Engineer may direct that the under strength batch be removed and replaced. The removal of the under strength concrete shall also include the removal of concrete that has obtained the required strength if the Engineer deems this necessary to obtain structural or visible continuity when the concrete is replaced.

The removal, and replacement of any under strength concrete, shall be made at no additional cost to the Owner. This shall include any new formwork required or any reinforcing steel that may be required. The Owner shall not be charged any additional costs for any extra work that is required because of the failure of any
Concrete to meet the minimum test requirements.

204.8.3.6 Concrete Strengths: The various strengths of concrete shall be installed as follows:

204.8.3.6.1 Class A, 4000 psi, Air-Entrained shall be used for all liquid containing and non-liquid containing structures, (footings, driveways, slabs, walls, columns and roofs.)

204.8.3.6.2 Class B, 3000 psi shall be used for sidewalks, curbs and thrust blocking.

204.8.3.6.3 Class C, 2000 psi shall be used for all non-structural fill concrete, mud slabs, over excavation concrete and other selective backfill conditions as approved by the Engineer.

204.8.3.6.4 Class D, 3000 psi pea gravel concrete (maximum aggregate size of 3/8") shall be used for all masonry fill, masonry columns cells, and masonry bond beams.

204.8.7 INSTALLATION

204.8.7.1 PREPARATION BEFORE PLACING - Water shall be removed from excavations before concrete is deposited. Hardened concrete, wood chips, shavings, and other debris shall be removed from interior of forms and inner surfaces of mixing and conveying equipment. Wood forms shall be oiled or, except in freezing weather, wetted with water in advance of pouring. Reinforcement shall be secured in position, inspected and approved by the Engineer before starting pouring of concrete.

204.8.7.2 CONVEYING - Concrete shall be conveyed from mixer to forms as rapidly as practicable and by methods, which will prevent segregation or loss of ingredients. It shall be deposited as nearly as practicable in its final position. Chutes used shall be such that concrete slides in them and does not flow. Chutes, if permitted, shall have a slope of less than 1 on 2. Where a vertical drop greater than five (5) feet is necessary, placement shall be through elephant trunks or similar devices to prevent segregation. Ready-mixed concrete shall be delivered with a load ticket showing mix proportions and the time mixing began for each
load. The load ticket shall be furnished to the Engineer.

204.8.7.3 PLACING - Concrete shall be placed before initial set has occurred and in no event after it has contained its water content for more than 30 minutes for site mixed concrete or 1 hour for ready-mixed concrete. Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces free from running water, or upon properly consolidated fills, but never upon soft mud or dry, porous earth. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.

204.8.7.3.1 If a section cannot be placed continuously, provide construction joints as herein specified. The concrete shall be compacted and worked in an approved manner into all corners and angles of the forms and around reinforcement and embedded fixtures as to prevent segregation of the coarse aggregate. Construction of forms for the lifts of vertical walls shall be such as to make all parts of the walls easily accessible for the placement, spading, and consolidation of the concrete as specified herein.

204.8.7.3.2 No “finished water” shall be surface applied during finishing efforts.

204.8.7.3.3 Curing methods shall be submitted to the Engineer and applied per manufacturer’s recommendations.

204.8 VIBRATION - All concrete shall be placed with the aid of mechanical vibration equipment as approved by the Engineer. Vibration shall be transmitted directly to the concrete; in no case shall it be transmitted through forms. The duration of vibration at any location in the forms shall be held to the minimum necessary to produce thorough compaction. Vibrations shall be supplemented by forking or spading by hand, and adjacent to the forms on exposed faces in order to secure smooth, dense and even surfaces, with particular care being taken to prevent coarse aggregate from becoming set too near any surfaces that are to receive rubbed finish.

204.8.9 CONSTRUCTION JOINTS - Construction joints shall be formed as indicated on
the drawings or as approved or directed by the Engineer. Contractor shall submit a joint location plan for each structure to the Engineer for approval 28 days prior to commencing concrete operations on that structure. Where indicated or required, dowel rods shall be used. All concrete at the joints shall have been in place not less than 12 hours, and longer if so directed by the Engineer, before concrete resting thereon is placed. Before placing is resumed, or commenced, excess water and laitance shall be removed, and concrete shall be cut away, where necessary, to insure a strong dense concrete at the joint. In order to secure adequate bond, the surface of concrete already in place shall be cleaned, roughened, and then spread with a one-half (1/2) inch layer of mortar of the same cement-sand ratio as is used in the concrete, immediately before the new concrete is deposited. The unit of operation is not to exceed 40 feet in any horizontal direction, unless otherwise required by the Drawings. Construction joints, if required, shall be located near the mid-point spans for slabs, beams or girders. Joints in columns or piers shall be made at the underside of the deepest beam or girder at least five (5) hours before any overhead work is placed thereon. Joints not shown or specified shall be so located as to least impair strength and appearance of work. Vertical joints in wall footings shall be reduced to a minimum. Placement of concrete shall be at such a rate that surfaces of concrete not carried to joint levels will not have attained initial set before additional concrete is placed thereon.

204.8.9.1. Girders, beams and slabs shall be placed in one operation. To insure a level straight joint in exposed vertical surfaces, a strip of dressed lumber may be tacked to the inside of the forms at the construction joint. The concrete shall be poured to a point one (1) inch above the underside of the strip. The strip shall be removed one (1) hour after concrete has been placed and any irregularities in the joint line leveled off with a wood float and all laitance removed. Waterstops shall be installed in all construction joints below grade or in liquid containing structures as noted on the Plans. Install as per SECTION 3.3, CONSTRUCTION JOINTS, EXPANSION JOINTS, & WATERSTOPS.

204.8.10 PATCHING

204.8.10.1 Any concrete which is not formed as shown on the Plans, or for any reason is out of alignment or level or shows a defective surface shall be considered as not conforming with the intent of these Specifications and
shall be removed from job by Contractor at his expense, unless the tender grants permission to patch defective area, which shall be done in accordance with the following procedure. Permission to patch any such area shall not be considered a waiver of the Engineer's right to require complete removal of defective work if patching does not, in his opinion, satisfactorily restore quality and appearance of surface. Suitable non-shrink, latex or epoxy mortar shall be used for patching and repairing defective surface if permitted by the Engineer.

204.8.10.2 After removing forms, all concrete surfaces shall be inspected and any poor joints, voids, stone pockets, all tie holes, or other defective areas shall be patched, if permitted by the Engineer. Where necessary, defective areas shall be chipped away to a depth of not less than one (1) inch with edges perpendicular to the surface. Area to be patched and a space at least six (6) inches wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. A grout of equal parts Portland cement and sand, with sufficient water to produce a brushing consistency, shall then be well brushed into the surface followed immediately by the patching mortar. The patch shall be made of the same material and of approximately the same proportions and shall not be richer than 1 part cement to 3 parts sand. White Portland cement shall be substituted for a part of the gray Portland cement to match color of the surrounding concrete. The proportion of white and gray cements shall be determined by making a trail patch. The amount of mixing water shall be as little as consistent with the requirements of handling and placing. The mortar shall be retempered without the addition of water by allowing it to stand for a period of one (1) hour during which time it shall be mixed occasionally with a trowel to prevent setting.

204.8.10.3 The mortar shall be thoroughly compacted into place and screened off so as to leave patch slightly higher than surrounding surface. It shall then be left undisturbed for a period of 1 to 2 hours to permit initial shrinkage before being finally finished. The patch shall be finished in such a manner as to match the adjoining surface. On surfaces where unlined forms have been used, the final finish shall be obtained by striking off the surface with a straightedge spanning the patch and held parallel to the
direction of the form marks.

204.8.10.4 Tie holes left by withdrawal of rods or the holes left by removal of ends of ties shall be filled solid with non-shrink grout after first being thoroughly wetted within 7 days of placement and prior to any area backfill.

204.8.11 SLAB FINISHES

204.8.11.1 Exterior Concrete Walks: After thoroughly consolidating the concrete the top surface shall be struck off with a straight edge and tamped or vibrated sufficiently to bring mortar to the surface. Finish with a wood float to a smooth, even surface and lightly broomed to provide "slip resistant" surface. Edges shall be rounded with a 1/4" radius.

204.8.11.2 Interior slabs to receive grout fill or mortar setting bed shall be finished by tamping concrete with special tools to force coarse aggregate below the surface, and screened with straightedges to bring surface to finish plane with a tolerance not exceeding 1/8" in 2 feet. Surface shall be left roughened sufficiently to produce good bond with topping material. Use stiff brushes, brooms or rakes as necessary to provide 1/8 inch deep grooves at maximum of 1/2 inch on center.

204.8.11.3 Top and bottom slabs of all structures and water carrying conduits except as noted otherwise on the Plans shall be finished as follows: The top of the slab shall be screened to grade and cross section; lightly tamped as required to bring up a good bed of mortar for finishing and re-screened as necessary. The surface shall then be finished with a wood float and leveling darby. No further finish will be required on top slabs of structures or conduits, which are to be buried. In the case of all exposed top slabs of structures and conduits, they shall be given a final wood float and a lightly broomed, slip resistant finish to a uniform surface, which conforms with accuracy to required shape, slope and grade. Slabs shall be edged as appropriate. No liquid hardener is to be applied to these surfaces.

204.8.11.4 Interior floor slabs that are not to receive any finish floor covering shall be "slip resistant finish" as follows: The top surface shall be steel
troweled and have a final finish applied by brushing lightly with a soft bristle brush to form a slightly roughened surface.

204.8.11.5 Liquid Hardener shall be applied to the floors where scheduled to be exposed concrete. Concrete surfaces to be treated must be thoroughly set and dry, clean and free of dust. Three applications of the liquid hardener are required, using one gallon per 100 square feet for the complete treatment. Apply hardener strictly according to the manufacturer's printed instructions. Liquid floor hardener is not required when a minimum of two (2) coats of Thompson's Waterseal or equal has been used as a curing and/or separating compound. Submit material and method to be used for Engineer's approval.

204.8.12 FINISH OTHER THAN SLABS

204.8.12.1 All top surfaces, other than slabs, not covered by forms, and which are not to be covered by additional concrete or fill shall receive a wood float finish without additional mortar. Care shall be taken that no excess water is present when the finish is made. Other surfaces shall be brought to finished elevations and left true and regular. All exposed top surface interior concrete shall be grouted smooth and given a cement wash of one part light colored Portland cement and two parts fine aggregate mixed with water to consistency of thick paint. Grout shall be cork or wood floated to fill all pits, air bubbles, and surface holes. Excess grout shall be scraped off with a trowel and rubbed with burlap to remove any visible grout film. Surface shall be kept damp during setting period. The finish for any area shall be completed in the same day and the limits of a finished area shall be made at natural breaks in finished surface. Painting of exposed-to-view concrete surfaces is specified under SECTION 9.1 - PAINTING of these Specifications.

204.8.12.2 Rubbed Finish:

Unless otherwise indicated, all faces (except top surfaces of slabs) exposed to view, such as walls, grade beams, columns, beams, walls of water carrying conduits to a point 1'-0" below normal water level, canopy soffits and fascias, etc. shall be finished as follows:
Forms shall be removed, as specified in SECTION - CONCRETE FORMWORK, and all fins removed, off-sets leveled, damaged places and depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in the proportion which has been employed for the particular class of concrete treated. The surface film of all such pointed places shall be carefully removed before setting occurs. After the point has set sufficiently to permit it, all exposed surfaces shall be dampened and rubbed with a No. 16 Carborundum stone, to a smooth even plane. Final rubbing shall be done with a No. 30 Carborundum stone, or an abrasive of equal quality, to obtain an entire surface of a smooth texture and uniformity in color. Mortar or grout worked up during rubbing shall be promptly removed by sacking with burlap or other suitable means so that no visible grout film or paste will remain. A cement wash or plaster coat shall not be used. All surfaces shall be finished uniformly smooth and washed clean. The rubbed finish for any area shall be completed in the same day and the limits of a finished area shall be made at natural breaks in the finished surface. If the Contractor does not provide suitable surface finish using Carborundum stones specified above, the Engineer, without additional cost to the Owner, may require the use of a power operated grinding machine or other methods to produce the desired finish.

204.8.12.3 Cementitious Waterproofing and Finish:

As an option to the rubbed finish, as specified herein, all faces (except top surfaces of slab) exposed to view, such as walls, grade beams, columns, beams, canopy soffits and facias, etc., shall be finished using "Thoroseal" coating or approved equal as described in the following paragraphs.

204.8.12.3.1 General

Forms shall be removed, as specified in SECTION 3.4 - CONCRETE FORMWORK, and all fins removed, off-sets leveled, damaged places and depressions resulting from the removal of metal ties or other causes shall be carefully pointed with a mortar of sand and cement in proportion which has been employed for the particular class of concrete treated. The surface film of all such pointed places shall be carefully removed before setting occurs. After the point has set sufficiently to permit it, all exposed surfaces shall receive the following treatment.
204.8.12.3.2 Mixing

Thoroseal plaster mix shall be prepared using a solution composed of not less than one part Acryl 60 (approximately two quarts Acryl 60 per bag) and three parts of clean, potable water (for ceilings, use 1 part Acryl 60 to 2-1/2 parts of the water). This solution shall then be added to the Thoroseal plaster mix slowly in sufficient quantity so that the mixture is the consistency of a heavy batter suitable for application by method specified. Color to be selected by the Owner.

204.8.12.3.3 Application

At Contractor's option, one of the following methods of application shall be selected:

204.8.12.3.3.1 Sprayed-on finish should be applied with plaster-type spray gun, not high pressure paint type. Spray on evenly distributed coat of Thoroseal plaster mix. To spot-fill deep holes, float or brush first coat before starting second spray application.

Thoroseal plaster mix shall be applied on average surfaces in two coats at the rate of 5 to 6 lbs. per square yard for concrete walls, 6 to 9 lbs. per square yard for masonry walls; but sufficient material shall be applied to fill all holes and voids.

204.8.12.3.3.2 Trowel and float finish - Apply light trowel coat of Thoroseal plaster mix over entire surface to be treated. The workman shall make sure the material is firmly pressed into all voids and leveled. Allow this coat to cure thoroughly before applying the regular trowel application. When surface is set so it will not roll or lift, float uniformly using a sponge float.

Thoroseal plaster mix shall be applied on average surfaces at the rate of 4 to 6 lbs. per square yard for concrete walls, 6 to 9 lbs. for masonry walls. If concrete is rough or untrue, 6 to 9 lbs. per square yard may be required, but sufficient material shall be
applied to fill and seal all pores and voids. This application will be approximately 1/8" thick. Leveling uneven surfaces will require more material per square yard.

To prevent shadowing of struck or deep masonry joints, or areas of unequal absorption (like some form marks), after key coat has cured for 5 days, apply a light trowel coat of Thoroseal plaster mix with Acryl 60 in the mixing water over the entire surface to be treated. Allow this coat to set thoroughly before applying the regular trowel application as outlined above.

Do not apply when temperatures are 40°F or due to fall below 40°F within 24 hours or to frozen or frost-filled surfaces.

204.8.12.4 CURING

204.8.12.4.1 General - Immediately following placing, all Class A and Class B concrete shall be protected from premature drying, hot and cold temperatures, rain, flowing water and mechanical injury. Maintain above 50°F and in moist condition for at least seven (7) days after placing for normal concrete and three (3) days for high early strength concrete. Comply with "Recommended Practice for Curing Concrete" ACI 308, unless otherwise indicated. Curing compound of satisfactory composition and characteristics may be used except on surfaces to which new concrete is to be bonded or surfaces scheduled to be painted or to receive other coating and provided such compound does not stain or discolor any surface which will be exposed. Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

204.8.12.4.2 Cold Weather Procedures - Protect concrete work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306, "Cold Weather Concreting", and as herein specified.

204.8.12.4.2.1. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat water and aggregates before mixing as required to obtain
a concrete mixture temperature of not less than 55°F, and not more than 80°F at point of placement.

204.8.12.4.2.2 Do not use frozen materials or materials containing ice, frost or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

204.8.12..4.2.3 Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

204.8.12.4.2.4 Contractor shall obtain and keep on the Project site a copy of the current edition of ACI 306, "Recommended Practice for Cold Weather Concreting", for reference during all concrete operations in cold weather.

204.8.12.4.3 Hot Weather Procedures When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305, "Hot Weather Concreting", and as herein specified.

204.8.12.4.3.1 Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing.

204.8.12.4.3.2 Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

204.8.12.4.3.3 Wet forms thoroughly before placing concrete.

204.8.12.4.3.4 Do not use retarding admixtures unless otherwise accepted in mix designs.

204.8.12.4.3.5 Contractor shall obtain and keep on the project site a copy of ACI 305R, "Hot Weather Concreting" for reference during all concreting operations in hot weather.
204.8.12.4.4 Protection from the Sun - All concrete shall be adequately protected from injurious action of the sun in a manner satisfactory to the Engineer.

204.8.12.4.5 Temperature Control - During and at the conclusion of the specified curing period, means shall be provided to ensure that the temperature of the air immediately adjacent to the concrete does not fall more than 3ºF in any 1 hour nor more than 30ºF in any 24 hours.

204.8.13 NON-SHRINKING GROUT - Where non-shrinking grout is called for on the Plan, it shall be mixed in strict accordance with the manufacturer's directions. It shall be of a type as recommended by the manufacturer for the particular application.

END OF SECTION
205 SUBMITTALS

All submittals shall be accompanied by a transmittal letter and/or cover letter that includes the project name and number, the contract specification number under which the equipment is being supplied, the Equipment ID number of the equipment being referenced, and the submittal revision number as appropriate.

205.1 Contractor shall submit, for each bid item, the manufacturer’s instructions and recommendations for installation, for subsequent testing of the units, and for ensuring they are in proper operation. These instructions shall be part of these specifications and binding on the contractor.

205.2 Contractor shall include, for each bid item, a work plan acceptable to the Engineer describing the duration and sequence of work. Plan shall be approved prior to commencement of work. All work requiring flow stoppage or removing equipment from service must be scheduled 48 hours in advance with Plant Superintendent. When flow stoppage is required for equipment installation, contractor shall have all necessary materials at the installation site prior to any flow stoppage, and shall proceed with installation of equipment to minimize downtime.

205.3 Contractor shall, within 15 days of issuance of Work Order, submit four (4) copies of the following items for review and approval - one (1) copy to be returned to Contractor following review, two (3) copies to be retained by Authority:

205.3.1 Product Data and Information: Submit catalog data including rating and descriptive literature of all components and systems for approval by Authority. This shall include items required by 204.

205.3.2 Itemized list with manufacturer’s part numbers, part descriptions and a schedule of values (unit prices) for the equipment proposed for each location.

205.3.3 Shop Drawings: Submit the following shop drawings for approval by Authority:

205.3.3.1 Bill of materials including manufacturers’ name and catalog number

205.3.3.2 Outline drawing showing dimensions, arrangement, and identification of components and nameplate schedule for all units
205.3.3.3 Individual schematic control diagrams for each unit.

205.3.3.4 Submittals should clearly identify items intended to be incorporated into the project. Mark or circle items clearly. Line through items or sizes that do not apply. Clearly identify where and what portion of the project the items are intended for use. Minimize “bundling” and separate important long lead time items out to coordinate and facilitate a review. Electrical and controls shall be submittal separately from related equipment.

205.3.4 Manufacturer’s start up, certifications and training requirements:

Manufacturer’s certification that the equipment is suitable and will perform within specification and manufacturer’s design operating parameters for the locations and conditions herein specified. Manufacturer’s services shall also include site visits by the Manufacturer’s Technical Representative’s prior to construction, during installation and for start-up, as necessary for an inspection, detailed start up report and Manufacturer’s certification of proper installation. Submit the Manufactures start-up report(s) and certification(s) of proper installation when they become available to the Engineer and during the week the equipment being put into service. Included final copies of the Manufacturer’s Start-up Certificates in the final O&Ms. Start-up report/Manufacture’s Certification should include pertinent start up details, equipment description, location, project information, complete initial set points, initial operational readings, equipment numbers and date and other pertinent system information for future operations and maintenance.

Training shall also be provided for the equipment and systems installed. Submit a draft training agenda, draft handouts, power point/video and a Manufacturer’s Technical Representative’s resume for acceptance prior to scheduling the start-up and training. Provide two separate training days, as coordinated with the Plant to accommodate both day and night shifts. The duration of the training should be a minimum of 4 hours per training day of classroom and field training or more, if recommended by the Manufacturer. A professional video services shall also be provided to cover both complete class room and field training sessions.
Deliverables are to include; the full training video on DVD with the final O&Ms to the City. Provide additional standard Manufacturer’s videos if available on the same DVD in the final O&M.

205.3.5 Safety Plan: This submittal will be checked for general conformance with Section 211 Safety requirements and applicable OSHA and local regulations. Notwithstanding, it is the Contractor’s responsibility to ensure that the plan is comprehensive and in full conformance with all applicable OSHA, federal, state and local regulations.

205.3.6 Work Plan: Submit for approval by Authority, the work plan clearly showing the work task sequencing plan and time requirements, including downtime durations. This shall include items required by 204.

205.3.7 Submit for approval by Authority, plans and specifications for any concrete pad, support, piping, or other construction modifications from original installation.

205.3.8 Warrantee Equipment Log: Submit within 90 calendar days from the issuing of the Notice to Proceed, a Warrantee Equipment Log draft spreadsheet complete with project equipment information and equipment numbers for review. From that point on, the log will be updated each month by the Contractor and be a handout in the Monthly Meetings. Upon project completion, the spreadsheet shall be completed with all required information such as equipment numbers, start up dates, training dates, O&M dates and other relevant information and transmitted to the Owner for their future use in maintaining the equipment. A sample spread sheet is available upon request. The warrantee log will be used as the tool to establish and agree on equipment warrantee period start date(s).

205.3.9 Schedule of values: Submit for approval by the Authority prior to and for the pay application process a proposal bid item based schedule of values with appropriate breakdowns. Contractor will be required to make appropriate and sufficient breakdown based on bid items, areas of work, scope, Subcontractor efforts and such relevant information that the pay application process can be reviewed more easily, as directed by the Authority.
205.4 Operations and Maintenance Manuals:

205.4.1 Contractor shall furnish to the Engineer two (2) hard copies and one soft searchable PDF of the preliminary Operation and Maintenance Manual complete for each piece of equipment and associated control systems furnished and installed.

205.4.2 Contractor shall furnish to the Engineer four (4) copies of all final O & M manuals on CDs/jump drives. CDs or jump drives shall be formatted in searchable pdf and shall contain all printed material included in the hard copies. A separate pdf folder shall be created for each Equipment numbered piece of equipment, within which all files pertaining to that piece of equipment shall be located.

205.4.3 Prior to each area of work reaching 80 percent completion, Contractor shall submit to the Engineer for approval two (2) copies of the O&M manual with all specified materials and contents. Submittal of the approval copies shall be made with the partial payment request for the specified completion. Within 30 days after the Engineer's approval of the two-copy submittal, Contractor shall furnish to the Engineer the remaining four (4) hard copies of the manual and the two searchable PDF copies on CD/jump drives. Contractor shall submit any missing material for the manual prior to requesting certification of substantial completion. On equipment with and requiring O&Ms, training and start-up, the last 10% of payment shall be for those items completed prior to applying for full payment of that item (100% payment).

205.4.4 Format and Contents: Each O & M manual shall include the following:

205.4.4.1 One copy of a completed EQUIPMENT NAMEPLATE AND SUMMARY DATA form.

205.4.4.2 One copy of the equipment Start-Up report and Manufacture’s certification of proper installation.

205.4.4.3 One copy of the manufacturer’s operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, troubleshooting, parts
list and recommended spare parts.

205.4.4.4 List of electrical relay settings and control and alarm contact settings.

205.4.4.5 Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems

205.4.4.6 Record drawings showing as-built schematic control diagrams for each unit and one-line diagrams.

205.4.4.7 Cross-references where required between the appropriate sections of the Contractor’s O&M manual and the manufacturers’ manuals.

205.4.4.8 The Contractor shall provide all required warrantee paperwork completed and filled in by the Contractor for the City’s use. The complete warrantee paperwork shall be specifically transmitted to the Plant Superintendent at time of start-up equipment being put into service and a separate copy be provided within the Final O&Ms also transmitted to the City.

205.5. Equipment Nameplate Information – Contractor shall, upon startup of each piece of equipment, complete the form, titled EQUIPMENT NAMEPLATE AND SUMMARY DATA, found at the end of this section, and shall include the completed form in the front of that equipment’s respective O & M manual. The form shall be included with each O & M manual copy submitted. Equipment ID nameplate requirements are found in specification section 204.3.6 of these specifications.

205.6 Submittals shall be sent to the following address:

Stephen Tolar, P.E.
Holloway, Updike and Bellen, Inc.
905-A South 9th Street.
Broken Arrow, OK 74012
(918) 251-0717
stolar@hubengineers.com
EQUIPMENT NAMEPLATE AND SUMMARY DATA

<table>
<thead>
<tr>
<th>Equipment Number:</th>
<th>____________________________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description (Include size):</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>Project #:</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>Spec. #:</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>Vendor:</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>Model #:</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>*Item or Drawing #:</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>*Serial #:</td>
<td>____________________________________________</td>
</tr>
<tr>
<td>Purchase Price:</td>
<td>$ __________________________________________</td>
</tr>
<tr>
<td>Date Placed in Service (for 1-yr Warranty):</td>
<td>__________________________________________</td>
</tr>
<tr>
<td>Manufacturer’s Warranty Period and End Date:</td>
<td>__________________________________________</td>
</tr>
<tr>
<td>Parts / Associated Details:</td>
<td>__________________________________________</td>
</tr>
<tr>
<td>Maintenance Schedule</td>
<td>(May be an attached sheet from O&amp;M Manual; do not use “See O&amp;M Manual”)</td>
</tr>
<tr>
<td>✓ Initial:</td>
<td>__________________________________________</td>
</tr>
<tr>
<td>✓ Weekly:</td>
<td>__________________________________________</td>
</tr>
<tr>
<td>✓ Monthly:</td>
<td>__________________________________________</td>
</tr>
<tr>
<td>✓ Semi-Annual:</td>
<td>__________________________________________</td>
</tr>
<tr>
<td>✓ Annual:</td>
<td>__________________________________________</td>
</tr>
</tbody>
</table>

| Item or Drawing # may not be unique. For example, it may be the same for a group of same size valves or gates, each one having this same number that is unique to the group. The Serial # should be listed only when unique to this individual piece of equipment, otherwise it is N.A. |

| Applicable Motor Information: | N.A. (Circle if not applicable) |
| Vendor: | __________________________________________ |
| Manufacturer: | __________________________________________ |
| Model #: | __________________________________________ |
| Item #: | __________________________________________ |
| Serial #: | __________________________________________ |
| Frame: | __________________________________________ Insul. Class: | ______________________ |
| Volts/Hz/Amps: | __________________________________________ |
| HP / RPM / SF: | __________________________________________ |
| Manufacturer’s Warranty Period and End Date: | __________________________________________ |
206 MONTHLY PROGRESS REPORTS AND PROGRESS MEETINGS

206.1 The Contractor shall submit monthly written project progress reports detailing the project’s progress to date, problems encountered or anticipated which impact project schedule, and plans for the next two weeks’ work.

206.2 Project progress reports shall be due as agreed upon during pre-work meeting.

206.3 Monthly progress meetings shall be scheduled on a weekday mutually agreeable to the Authority and the Contractor and shall be specified at the pre-work conference. The Contractor shall run the Monthly Meetings for the duration of the project and provide a meeting agenda including work completed, work planned, project, updated project schedule and other pertinent project status information.

206.4 The contractor shall submit a work progress and planned completion schedule for each bid item at the monthly progress meeting. The pre-work conference will constitute the first monthly progress meeting.

206.5 The Contractor shall maintain, update and submit an Equipment Log at each monthly meeting that lists each piece of equipment by Equipment ID number and lists Startup Date, Warranty Start Date and O&M Manual Submittal Date, among other project details. The spread sheet document shall be a shared document and submitted to the City at the end of the project for City’s future use. A sample Equipment log is available upon request.

207 SECURITY

207.1 Each project site where work is to be performed under this Contract is a secured site. The Contractor shall be responsible for security as described in this section.

207.2 Site Access: The Contractor shall respect all existing security measures at each project site, and shall implement the following measures to apply to all work performed under this Contract. Coordination for Plant access and City of Tulsa security pass access will be required.

207.2.1 Work at Haikey Creek shall be restricted to the hours defined by RMUA GC-19 unless otherwise authorized by the Plant Superintendent.

207.3 Common Requirements

208.3.1 Identification Badges: An Identification Badge, issued by the City of Tulsa Security Office, is required for the following people:
· The driver of each vehicle that will be entering the facility multiple times or on a regular basis.

· Sub-contractors and foremen that will be supervising other workers.

The Identification Badge also functions as an Access Card to allow access through the front gate of the facility. One year is the maximum time that an Access Card is active.

208.3.2 Contractor will coordinate with the Engineer to request Identification Badges. Application for an Identification Badge will require a background investigation. Each person that is applying for an Identification Badge will need to complete the following two (2) forms:

· City of Tulsa Access Card / Identification Card Request Form

· City of Tulsa Security, Background and Prescreen Investigation Form

A current soft copy of the forms can be obtained from the Engineer.

208.3.3 The Contractor will send the completed forms as required. Approved individuals will coordinate with the City of Tulsa Security Office to complete the process and obtain their Identification Badge.

208.3.4 The Contractor will coordinate with the Engineer to request reactivation of Access Cards. Reactivation may require re-application and additional background investigation.

207.4 Contractor shall maintain a log book listing as a minimum the names of all persons admitted to each secured site by the Contractor, the purpose of the site visit, the dates and times of arrival at the site, entry to the secured site, and departure from the site.

207.5 Contractor and Authority acknowledge that Contractor shall not solely be responsible for all secured access to the site, that City personnel will have access and will be performing their regular duties pertaining to the operation and maintenance of the site facilities, and that security at the site shall require the cooperation of all persons authorized to access the site for the performance of their work. To the extent the Contractor is responsible for and has control of secured access, Contractor shall restrict site access to only persons essential to the performance or inspection of the work being performed under this Contract.
207.6 Contractor shall provide Engineer twenty-four (24) hours advance notification of any delivery of equipment or materials to the site, and shall make arrangements with Engineer to provide for inspection of such delivery.

207.7 Any observation by the Contractor of activity at or associated with the project site that Contractor observes and considers to be unusual or suspicious in nature, or that Contractor believes poses a threat to the integrity or welfare of the project site or associated facilities, shall be duly noted at the time of the observation in the log book identified in item B above. Any such observation shall be immediately reported to the Engineer.

207.8 No statement pertaining to security in these Specifications shall constitute a contract between Contractor and Authority for the performance of security services.

208 SAFETY

208.1 Contractor shall be responsible for performing all work under this contract in a safe manner and in compliance with all applicable local, state, and federal safety and health regulations. All of the following requirements shall apply:

208.2 Contractor shall submit a site safety plan prior to start of work. Contractor's attention is directed to safety regulations applicable to the work under this contract, which include but are not limited to the following:

208.2.1 OSHA Standards 29CFR1910.147, the control of hazardous energy (Lockout/Tagout)

208.2.2 Fire Prevention and Protection: The Contractor shall take all necessary measures to prevent fire, and shall provide satisfactory firefighting means at the location of work.

208.2.3 Condition of Equipment and Materials: All equipment, tools, and appliances, and materials used in connection with the project shall be handled and operated only when they are in safe operating condition and in accordance with a standard safety procedure.

208.2.4 Confined Space Entry: Contractor shall determine if any work areas in this contract are considered permit spaces for entry, as defined in OSHA regulations, and shall perform all work so determined in accordance with all applicable state and federal labor, safety, and health regulations. The Contractor shall transmit with each pay application all the months copies of the Contractors confined space permits to the City and at the end of
the project with final pay application submittal a complete package of a copy of all the project's Contractor confined space permits.

208.2.5 Combustible - Explosive Atmospheres: Contractor shall determine if any work areas in this contract are considered combustible and explosive spaces for entry, as defined in OSHA regulations, and shall perform all work and employ equipment in accordance with all applicable state and federal labor, safety, and health regulations.

209 PROTECTION OF PROPERTY

209.1 The protection of City, State and Government equipment, fences, gates, signs, and other City property is of prime importance, and if damaged, destroyed or removed, they shall be repaired, replaced, or paid for by the Contractor. Disturbance to this property must first be approved by the agency which controls it.

209.2 No valve or other control on any utility main or building service line shall be operated for any purpose by the Contractor. Schedule work as required to provide adequate notice to Authority to allow them to provide personnel to operate valves.

209.3 At places where the Contractor's operations are adjacent to, or crossing, the plane of railway, telegraph, telephone, electric, and gas lines, or water lines, sanitary sewers, and storm sewers, damage to which might result in expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made. Contractor shall notify the Notification Center of Oklahoma One-Call System, Inc., of any excavation or demolition prior to the commencement of such work. Notification shall be made no sooner than then (10) days nor later than forty-eight (48) hours prior to start of work, excluding Saturdays, Sundays, and legal holidays.

209.4 The Authority has attempted to locate all storm sewers, culverts, buried telephone or electrical conduits, sanitary sewers, water mains, and gas mains that might interfere with the construction of this project. The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner and duplication or rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

209.5 It shall be the responsibility of the contractor to follow all rules and regulations set forth by the Oklahoma Department of Environmental Quality with regards to storm
water runoff associated with construction activities involving the disturbance of land. The contractor shall review the regulations and determine if a DEQ storm water discharge permit is required. If a permit is required, it is the responsibility of the contractor to apply for and obtain the permit prior to disturbance of soil. If a permit is not required, the contractor shall still take all necessary action to comply with DEQ rules.

209.6 In the event the contractor in any way fails to comply with the requirement of protecting, repairing, and restoring of any utility or utility service, the Engineer may, upon forty-eight (48) hours’ notice, proceed to protect, repair, rebuild or otherwise restore such utility or utility service as may be deemed necessary, and the cost thereof will be deducted from any money due or which may become due the contractor pursuant to the terms of his contract.

210 PROTECTION OF MATERIALS

210.1 All materials and equipment delivered to the work site shall be adequately housed and protected against damage or deterioration as required by the equipment manufacturer. The Contractor shall keep his storage yard(s) in good order, arrange his materials neatly, and protect them from damage.

211 REFERENCES TO OTHER SPECIFICATIONS

211.1 Where a referenced American Society for Testing and Materials (ASTM), National Electric Code (NEC), National Electrical Manufacturers Association (NEMA), American National Standards Institute (ANSI), Institute of Electrical and Electronics Engineers (IEEE), or other agency designated specification is specified for a material, component, or device, that designated specification shall be the current revision, either tentative or adopted. If a referenced specification is in disagreement with these specifications, the Tulsa Metropolitan Utility Authority specifications shall govern.

212 CLEAN-UP

212.1 Immediately upon completion of the work at each site in the contract, the Contractor shall remove all excess materials, equipment, tools, and debris, and restore the site to a condition and in a manner satisfactory to the Engineer.

213 PLACING WORK IN SERVICE

213.1 If desired by the Authority, portions of the work may be returned to service when completed, and the Contractor shall give prior access to the work for this purpose, but such use and operation shall not constitute an acceptance of the work. Any
such return to service shall comply with Section GC-38 of the General Conditions of these Contract Documents and Specifications.

213.2 **Warranty:** All equipment and work shall have a one (1) year factory warranty from date of acceptance, which shall include all materials and labor.

### 214 PAYMENT

214.1 Contractor shall submit a schedule of values for all major items of work as a basis for each partial payment. Payments will be made in accordance with section GC-29 of the General Conditions of these Contract Documents and Specifications. Contractor shall submit the SOV in sufficient time prior to the first pay application for the Engineer's review. Contractor should anticipate a typical submittal review durations for the projects SOV review.

214.2 Contractor's attention is directed to the Sales Tax Exemption Document in these Contract Documents and Specifications. Contractor shall have the option of instructing vendors to directly bill the Authority for materials the Contractor purchases while performing work under the terms of this Contract.

214.3 Payment shall be made for a Mobilization Allowance bid item. See specification section 203.998 for additional details.

END OF SECTION