PRMH20230940

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

Project Manual

for

Kaiser Permanente
Puyallup Medical Center
Roof Top Units Replacement & Mechanical Improvements [CAP026111]

Architect:

nbbj

Engineer:

PAE

pae-engineers.com

Project No. 102908.00

Construction Documents

06.23.2023

PART 1 GENERAL

1.01 SUMMARY

A. The intent of Division 23, HVAC Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include work specified in Division 23, HVAC and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

B. The Drawings that accompany the Division 23, HVAC Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.

C. The General and Supplemental Conditions apply to this Division, including but not limited to:
   1. Drawings and specifications.
   2. Public ordinances, permits.
   3. Include payments and fees required by governing authorities for work of this Division.

D. Division 01, General Requirements, General Requirements, applies to this Division.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Products and equipment prohibited from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
   2. General: Work and materials conforms to the local and State codes, and Federal, State and other applicable laws and regulations.
   3. Contractor responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

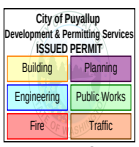
B. New materials and equipment. Work of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire mechanical system and apparatus operates at full capacity without objectionable noise or vibration.

E. Install equipment level and true. Housekeeping pads and curbs account for floor or roof slope.

F. Materials and Equipment:
   1. Each piece of equipment furnished meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting requirements will not be acceptable, even though specified by name along with other manufacturers.
   2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.



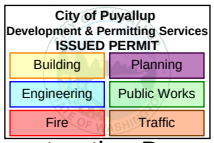
3. Furnish materials and equipment of size, make, type, and quality herein specified.
4. Equipment scheduled by performance or model number considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements, or any other differences which impact the project.

G. Workmanship:
1. General: Install materials in a neat and professional manner.
2. Manufacturer's Instructions:
   a. Follow manufacturer's directions where they cover points not specifically indicated.
   b. If conflict with the Drawings and Division 23, HVAC Specifications, obtain clarification before starting work.

H. Cutting and Patching:
1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Do no pierce beams or columns without permission of Architect and then only as directed.
5. Restore new or existing work cut or damaged to its original condition. Where alterations disturb lawns, paving, walks, etc., surfaces repaired, refinished, and left in condition existing prior to commencement of work.

1.04 SUBMITTALS

A. Shop Drawings:
1. The Contract Drawings indicate the general layout of the piping, ductwork, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of piping, ductwork, and equipment installations. Shop Drawings new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. Drawings the same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. Drawings fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
2. Prepare in two-dimensional format.
3. Include but are not limited to:
   a. Complete floor plans with sheet metal and HVAC piping to a minimum of 1/4-inch equals 1-foot scale.
   b. Sheet metal and HVAC piping of mechanical and fan rooms to a minimum of 1/2-inch equals 1-foot scale.
   c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
   d. Controls and Instrumentation: Scale and drawing sizes to suit controls supplier.
   e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment not less than 1/4-inch equals 1-foot scale.
   f. Superplot plans of above ground work with a colored overlay of trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.



g. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.
h. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.
i. Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.

4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:
1. In general, submit product data for review on scheduled pieces of equipment, on equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications, and data sheets. Data sheets include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.
4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:
1. Shop Drawings and Product Data:
a. Refer to Division 01, General Requirements for additional requirements related to submittals.
b. Submit copies of shop drawings and product data for Work of Division 23, HVAC in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, Article and paragraph, and mark if applicable.
c. Submit electronic copies of shop drawings and product data for Work of Division 23, HVAC in PDF format with each item filed under a folder and labeled with its respective specification section number, Article and paragraph and mark if applicable.
d. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
e. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, included with the original submittal. Controls and Instrumentation submittals may lag but complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

D. Contractor Responsibilities:
1. Submit submittals one time and are in proper order.
2. Ensure that equipment will fit in the space provided.
3. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.05 AS-BUILT DRAWINGS

A. Provide 3D model and record drawings at the end of the project on CD-ROM.

B. 3D model in any of the following format:
1. AutoCAD

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2. Revit
3. Navisworks

C. Record Drawings: Provide hard copies and pdf format.
1. Drawings include the following:
a. Project Specific Titleblock.
b. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.

1.06 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNER'S INSTRUCTIONS

A. Refer to Division 01, General Requirements for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature on 8-1/2-inch by 11-inch sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover phases of control.

D. Furnish competent engineer knowledgeable in this building system for minimum of one 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Keep a log of this instruction including dates, times, subjects, and those present and present such log when requested by Architect.

1.07 PROJECT CONDITIONS

A. Existing Conditions:
1. Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work.
2. Include related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check information and report discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, the City, and Utility Company.

1.08 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

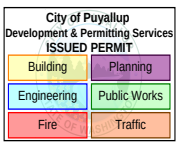
C. Correct warranty items promptly upon notification.

1.09 PROVISIONS FOR LARGE EQUIPMENT

A. Make provisions for the necessary openings in building to allow for admittance of equipment.

1.10 TEST REPORTS AND CERTIFICATES

A. Submit one copy of test reports and certificates specified herein to the Architect.



1.11 SUBSTITUTIONS

A. Submit requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 PRODUCTS

2.01 ACCESS PANELS

A. Furnish under this Division as specified in another Division of work.

2.02 PIPE AND DUCT SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.03 FLOOR, WALL AND CEILING PLATES

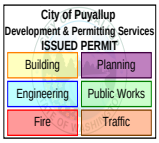
A. Furnish stamped split type plates as follows:
   1. Floor Plates: Cast brass, chromium plated.
   2. Wall and Ceiling Plates: Spun aluminum.

2.04 ELECTRICAL EQUIPMENT

A. General: Equipment and installed work as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available fault current rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment with a Short Circuit Current Rating (SCCR) that meets the bracing requirement.

C. Motors – AC Induction:
   1. Furnish as integral part of driven equipment.
   2. Drip proof induction type with ball bearings unless noted otherwise.
   3. Motors 1 hp and above premium energy efficient type, except for emergency equipment motors.
   4. Built to NEMA Standards for the service intended.
   5. Rated for voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.
   6. Energy Efficient Motors:
      a. Baldor
      b. Westinghouse
      c. General Electric
      d. Or approved equal.



7. Motors meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	KW	900	1200	1800	3600
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5

8. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
9. Refer to individual product sections for additional motor requirements.
10. Furnish motors on belt drive equipment of nominal nameplate horsepower not less than 120 percent of equipment brake horsepower required for performance specified.
11. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.
12. Motors controlled by variable frequency drives inverter duty rated and have Class F insulation or better. Withstand repeated voltage peaks of 1600V with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
13. Motors served from variable frequency drives equipped with shaft grounding system which provide a path for current to flow between the shaft and motor frame. SGS or equal.
14. Motors located in environment air plenums not tied to air handling functions totally

D. Motors – Electronic Commutation (EC):
1. Furnished as integral part of driven equipment.
2. Permanently lubricated with ball bearings unless noted otherwise.
3. Internal motor circuitry converts AC power supplied to the motor to DC power to operate the motor.
4. Speed controllable down to 20 percent of full speed.
5. Motor efficiency at a minimum of 85 percent at all speeds.
6. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
7. Refer to individual product sections for additional motor requirements.
8. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Quick trip devices hermetically sealed motors.
9. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.

E. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

F. Equipment Wiring:
1. Interconnecting wiring within or on a piece of mechanical equipment provided with the equipment unless shown otherwise.
2. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

G. Control Wiring: Control wiring for mechanical equipment provided under Section 23 09 00, Instrumentation and Controls for HVAC.

H. Codes: Electrical equipment and products bear the UL label as required by governing codes and ordinances.

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PART 3 EXECUTION

3.01 ACCESS PANELS

A. Install in accord with manufacturer's recommendations, coordinated with architectural features.

B. Provide 2-hour fire rated doors where required bearing the UL label.

C. Furnish 18-inch by 18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.

D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.02 SLEEVES

A. Interior Floor and Wall Sleeves:
   1. Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork.
   2. Where pipe or ductwork is insulated, provide sleeve large enough to provide 3/4-inch clearance around insulation. Maintain continuous insulation as it passes through sleeve.
   3. Penetrations through mechanical room and fan room floors watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Sleeves through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping or duct material, size and service.

C. Sleeves specified or indicated at fire damper penetrations take precedence over this article.

D. Exterior Wall Sleeves Below Grade:
   1. Provide water tight sleeves. Install at pipes entering building below grade and where shown.
   2. Adjust to provide positive hydrostatic seal.
   3. Follow manufacturer's procedure for installing and tightening seal.
   4. Secure sleeves against displacement.

E. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

F. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

G. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

H. Floor sleeves maintain a water barrier by providing a water tight seal or they extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated.

I. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members provided so pipes are floor supported.

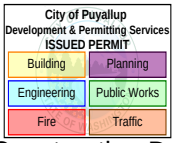
J. Special sleeves detailed on drawings take precedence over this section.

3.03 CLEANING

A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.



3.04 EQUIPMENT PROTECTION

A. Keep pipe, ductwork, and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment, and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Keep duct system free of construction debris. Maintain new duct system to Advanced Level of cleanliness as defined by SMACNA Duct Cleanliness for New Construction Guidelines.

C. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

D. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.05 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms, and walkways.

3.06 FLOOR, WALL, AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe and duct.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates not penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.07 PAINTING

A. General:
   1. Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.
   2. Exposed work under this Division receives either a factory painted finish or a field prime coat finish, except:
      a. Exposed copper piping.
      b. Aluminum jacketed outdoor insulated piping.

B. Equipment Rooms and Finished Areas:
   1. Insulation: Not painted.
   2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
   3. Steel Valve Bodies and Bonnets: One coat of black enamel.
   4. Brass Valve Bodies: Not painted.
   5. Equipment:
      a. One coat of grey machinery enamel.
      b. Do not paint nameplates.
   6. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers, and registers flat black.

C. Concealed Spaces (above ceilings, not visible):
   1. Insulation: Not painted.
   2. Do not paint the following:
      a. Hangers
      b. Uninsulated Piping
      c. Miscellaneous Iron Work

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d. Valve Bodies and Bonnets

D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.

E. Roof Mounted Equipment:
1. Paint two coats of exterior machinery enamel.
2. Color as selected by Architect.
3. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.

F. Exterior Black Steel Pipe:
1. Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel.
2. Painting schemes comply with ANSI A13.1.

3.08 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.09 ELECTRICAL EQUIPMENT

A. Ductwork or piping for mechanical systems not serving electrical space not installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Ductwork or piping for mechanical systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

END OF SECTION

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PART 1 GENERAL

1.01 SUMMARY

A. This Section includes Design-Build work.

B. This Section includes:
   1. Supports
   2. Anchors

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment

D. Section 23 07 00, Insulation for HVAC

E. Section 23 21 13, Pipe and Pipe Fittings HVAC

1.03 QUALITY ASSURANCE

A. Provide pipe and equipment hangers and supports in accordance with the following:
   1. Design supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork when not shown on the Drawings.
   2. Hangers, supports and sway braces to be fabricated in accordance with ANSI B31.1 and MSS SP-58 and SP-89.
   3. Use components for intended design purpose only. Do not use for rigging or erection purposes.
   4. Seismic restraints and anchorages shall resist seismic forces as specified in the state and local code or by the authority having jurisdiction for the seismic zone in which the project is constructed.
   5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
   6. Seismic Restraints:
      a. Shall not introduce stresses in the piping caused by thermal expansion or contraction.
      b. Shall not exceed forces or design limits of the piping per ASME B31.9.
      c. Provide in accordance with the latest edition of the SMACNA, Seismic Restraint Manual Guidelines for Mechanical Systems" for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
      d. Provide in accordance with the local applicable codes.
      e. Follow provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.
   7. Piping Connections to Equipment:
      a. Shall not introduce twisting, torsion, or lateral forces or moments on the equipment.
      b. Shall be supported and isolated in a manner not to exceed the equipment's point of connection load limitations.

B. Engineered Support Systems: Provide design services for the following support systems:
   1. Supports and seismic restraints for suspended piping, ductwork, and equipment.
   2. Support frames such as pipe racks or stanchions for piping, ductwork, and equipment which provide support from below.
   3. Equipment, ductwork, and piping support frame anchorage to supporting slab or structure.

1.04 SUBMITTALS

A. Submit the following:
   1. Shop Drawings of contractor fabricated support structures.

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2. Structural Details and Calculations:
   a. Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
   b. Details and calculations to bear the seal of a professional engineer registered in the state having jurisdiction.
3. No other submittals required under this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Supports:
1. Unistrut
2. Superstrut
3. Powerstrut
4. Kinline
5. B-Line Systems
6. AnvilStrut

B. Pipe Hangers:
1. Anvil
2. Superstrut
3. B-Line Systems
4. Tolco
5. ERICO
6. Pipe Shields Inc.
7. Rilco

2.02 SUPPORTS

A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.

B. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.

C. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.

D. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.03 PIPE HANGERS

A. Uninsulated Horizontal Copper Piping:
1. 2-inch and Smaller: Anvil CT-65, CT-69.
2. Larger than 2-inch:
   a. Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods.
   b. Electricians' tape is unacceptable.

B. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.

C. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
1. 2-inch and Smaller: Anvil 65, 104 or 260.

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PART 3 EXECUTION

3.01 HANGERS AND SUPPORTS

A. General:
1. Install support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required, and as detailed on the Drawings.
2. Provide adjustable hangers for pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
4. Except as otherwise indicated for exposed continuous pipe runs, install hangers, and supports of same type and style as installed for adjacent similar piping.
5. Support piping within 2-feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:
1. Refer to Section 23 07 00, Insulation for HVAC for insulation requirements.
2. Insulated Piping Systems with Vapor Barrier Insulation:
   a. Install hangers outside of insulation.
   b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.
3. Heating Water (over 230 degrees F), Medium Pressure Steam and High Pressure Steam (Non-Vapor Barrier Insulation):
   a. As specified for Insulated Piping Systems with Vapor Barrier Insulation.
4. Other insulated Piping Systems with Non-Vapor Barrier Insulation:
   a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
   b. If hangers are installed outside of insulation, provide insulation protection shields at support locations on piping 1-1/2-inch and larger.
   c. On piping larger than 2-inch, provide insulation saddles at each support location.

C. Vertical Piping:
1. Support Spacing: Provide support at minimum spacing in accordance with state and local codes.
2. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
3. Provide mid-story vertical guide support where floor to floor distances exceed spacing as required by state and local codes. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
4. Risers that are not subject to thermal change to be supported at each floor of penetration.
5. Risers that are subject to thermal change require engineered supports. Size supports to carry forces exerted by piping system when in operation. Riser supports follow the provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Horizontal Piping:
1. Trapeze Hangers:
   a. Multiple pipe runs where indicated supported on channels with rust resistant finish.
   b. Provide necessary rods and supporting steel.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

2. Support Spacing:
   a. Provide support at maximum spacing in accordance with state and local codes and any applicable manufacturer requirements.
   b. Support piping within 2-feet of each change in direction.
   c. Provide piping with acoustical lagging wrap supported a maximum of 5-feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:
   1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
   2. Provide horizontal bracing on horizontal runs 1-1/2-inch and larger and exceeding 50-feet in length at 75-foot intervals and as required to provide stabilized piping systems.
   3. Provide additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
   4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION

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Development & Permitting Services
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Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Neoprene Waffle Pad
   2. Restrained Neoprene Mount
   3. Spring Isolators
   4. Springs with Restraints
   5. Base with Springs
   6. Inertia Base
   7. Isolating Spring Hangers
   8. Isolating Neoprene Hangers
   9. Rooftop Air Handling Unit Isolation Curb
   10. Isolating Sleeves
   11. Seismic Restraints
   12. Flexible Sphere Connector
   13. Flexible Hose Connector

B. Isolation of mechanical equipment as indicated on the Drawings and specified herein.

C. Seismic restraint of equipment, piping, and ductwork.

1.02 RELATED SECTIONS:

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 29, Hangers, Supports and Anchors for HVAC

D. Section 23 31 01, HVAC Ducts and Casing-Low Pressure

1.03 QUALITY ASSURANCE

A. Single manufacturer select and furnish isolation required, except packaged equipment with integral isolators meeting all the isolation and seismic requirements of this Specification.

B. System of vibration isolators and seismic controls designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.

C. Isolation performance requirements are indicated in the specifications. Deflections indicated are nominal static deflections for specific equipment supported.

D. Seismic snubbers, restrained isolator housings, and cable system components have anchorage preapproval OPM number from OSHPD in the State of California verifying the maximum certified load ratings.

E. Isolator Stability and Rated Capacity:
   1. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.
   2. Springs have a minimum additional travel to solid equal to 50 percent of the rated deflection.

F. Seismic Restraints:
   1. Restraint of equipment, piping, and ductwork to be in accordance with the current state and local Building Code.
   2. Calculations in accordance with current state and local Building Code.

1.04 SUBMITTALS

A. Submit the following:
   1. Submit Shop Drawings showing complete details of construction for steel and concrete bases including:
      a. Equipment mounting holes.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

b. Dimensions
c. Isolation selected for each support point.
d. Details of mounting brackets for isolator.
e. Weight distribution for each isolator.
f. Code number assigned to each isolator.

2. Submit product data and calculation sheets for isolators, showing:
   a. Size, type, load rating, and rated deflection of each required isolator.
   b. Percent of vibration transmitted based on the lowest disturbing frequency of the equipment.
3. Structural Details and Calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads stamped and signed by a registered structural engineer.
4. Installation report as specified in PART 3 of this Section.
5. Operation and maintenance data.

1.05 EQUIPMENT VIBRATION ISOLATION

A. Provide a balanced set of vibration isolators for each piece of equipment listed in the Equipment Schedules.

B. Isolation work to include, but not necessarily be limited to, the following:
1. Isolation support of motor-driven equipment.
2. Inertia base frames in conjunction with isolation.
3. Isolation support of air-handling housings.
4. Isolation support of piping, piping risers, and ductwork.
5. Penetration isolation of pipework, ductwork, and conduits through walls, floors, or ceilings.
6. Flexible connections of ductwork and piping to equipment.

C. Each piece of rotating equipment must meet a reasonable criterion for maximum vibration levels at each bearing, while in operation. The criteria for varying operating speeds are given as follows:
1. Rotating equipment operating at peak vibration velocities must not exceed 0.08-inch/second.
2. If it is discovered that the operating vibration velocities exceed this criteria, the equipment repaired or replaced at no expense to the owner until approval of the equipment is given by the Engineer.

D. Provide components or materials not specially mentioned herein, but necessary to the proper vibration isolation of the equipment.

1.06 CONTRACTOR RESPONSIBILITY

A. Vibration isolation devices, including auxiliary steel bases and pouring forms, design and furnish by a single manufacturer or supplier.

B. Adequately restrain all equipment, piping, and ductwork to resist seismic forces. Design and select restraint devices to meet seismic requirements as defined in the latest issue of the International Building Code under Earthquake Loads and applicable state and local codes.

C. Have the following responsibilities:
1. Selection, installation, adjustment, and performance of vibration isolators which will meet the requirements given on the plans or in the Specifications.
2. Provide Engineering drawings, details, supervision, and instruction to assure proper installation and performance.
3. Provide whatever assistance necessary to ensure correct installation and adjustment of the isolators.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Type 5 – Base with Springs:
   1. Mason WFSL
   2. Kinetics Noise Control
   3. Vibrex

B. Isolating Sleeves:
   1. Potter-Roemer PR isolators
   2. Grinnell Semco Trisolators

C. Flexible Sphere Connector:
   1. Mason Type SFU, SFDEJ, or SFEJ

D. Flexible Hose Connector:
   1. Mason Type FFL, MN, CPS or CPSB
   2. HCi
   3. Metraflex

2.02 TYPE 5 - BASE WITH SPRINGS

A. Steel base with wide flange beams and springs.

B. Provide minimum clearance of 1-inch.

C. Depth of base equal to 10 percent of the span between supports, 6-inch minimum.

D. Provide external height saving brackets.

E. Curb waterproofing shall consist of a continuous flexible flashing attached over the lower curb waterproofing.

F. All spring locations shall have accessibility to adjust springs.

G. Curb provides continuous support for equipment and be constructed to resiliently resist wind and seismic forces.

H. Construction of curb must not enable rigid connection between vibrating equipment and building structure.

I. Provide provisions for sloped roof, plenum curb, tall curb, and duct openings where required by installation conditions.

2.03 ISOLATING SLEEVES

A. Provide for piping through walls and floors of penthouses and chiller room. Size for piping as required.

2.04 SEISMIC RESTRAINTS

A. General Requirements:
   1. Provided for equipment, piping and ductwork, both supported and suspended.
   2. Bracing of piping shall be in accordance with state and local code requirements and ASCE 7 Seismic Design Requirements for Nonstructural Components, whichever is most stringent.
   3. Bracing of ductwork shall be in accordance with the state and local code requirements, ASCE 7 Seismic Design Requirements for Nonstructural Components, and with the provisions set forth in the SMACNA seismic restraint manual.
   4. The structural requirements for the restraints, including their attachment to the building structure, shall be reviewed and approved by the Structural Engineer.
   5. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

B. Supported Equipment:
   1. All-directional Seismic Rubbers: Interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.
   2. Replaceable bushing and minimum of 1/4-inch thick. Rated loadings not to exceed 1000 psi.
   3. An air gap of 1/4-inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces.
   4. Snubber End Caps:
      a. Removable to allow inspection of internal clearances.
      b. Rotated neoprene bushings be rotated to ensure no short circuits exist before systems are activated.
   5. Snubber: Mason Industries, Inc. Type Z-1225

C. Bracing of Pipes:
   1. Provide seismic bracing of piping as detailed below to meet the building code requirements:
      a. Exception: Piping suspended by individual hangers need not be braced where the following criteria are met.
         1) Distance between the top of the pipe to the bottom of the support structure is 12-inches or less.
         2) Seismic braces are not required on high deformability piping when the Ip=1.0 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 3-inch diameter or less.
         3) Seismic braces are not required on high deformability piping when the Ip=1.5 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 1-inch diameter or less.
   2. Seismic braces for pipes on trapeze hangers may be used.
   3. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints, or where pipes connect to equipment.
   4. Cast iron pipe of all types, glass pipe, and any other pipe joined with a shield and clamp assembly, where the top of the pipe is 12-inches or more from the supporting structure, shall be braced on each side of a change in direction of 90 degrees or more. Riser joints on unsupported sections of piping shall be braced or stabilized between floors.
   5. Vertical risers shall be laterally supported with a riser clamp at each floor. For buildings greater than six stories high or for piping subject to thermal change all risers shall be engineered individually.

D. Bracing of Ductwork:
   1. Brace rectangular ducts with cross sectional areas of 6 square feet and larger. Brace flat oval ducts in the same manner as rectangular ducts. Brace round ducts with diameters of 28-inches and larger. Brace flat oval ducts the same as rectangular ducts of the same nominal size.
   2. Exception: No bracing is required if the duct is suspended by hangers 12-inches or less in length, as measured from the top of the duct to the bottom of the support where the hanger is attached.
   3. Transverse bracing shall occur at the interval specified in the SMACNA tables or at both ends if the duct run is less than the specified interval. Transverse bracing shall be installed at each duct turn and at each end of a duct run, with a minimum of one brace at each end.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

4. Longitudinal bracing shall occur at the interval specified in the SMACNA tables with at least one brace per duct run. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it if the bracing is installed within four feet of the intersection of the ducts and if the bracing is sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
5. Install duct flex connections at equipment connections to accept expected differential displacement and protect the equipment connection from damage.

E. Suspended Equipment and Piping and Ductwork:
1. Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
2. Cable must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
3. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.
4. Steel angles or strut, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be type SRC or UCC as manufactured by Mason Industries, Inc.
5. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

2.05 FLEXIBLE SPHERE CONNECTOR

A. Flexible EPDM pipe connectors shall be manufactured of multiple plies of Kevlar tire cord fabric and EPDM; both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement.

B. Connectors up to and including 2-inch diameter may have a single sphere and threaded ends. Connectors 2-1/2-inch and larger shall be manufactured with twin spheres up to 12-inches and a single sphere on larger sizes and floating steel flanges recessed to lock the connectors raised face EPDM flanges.

C. Connectors shall be rated a minimum of 150 psi at 220 degrees F. Connections shall be pre-extended as recommended by the manufacturer to prevent additional elongation under pressure.

D. Provide expansion joint control rods and install per the manufacturers installation recommendations.

2.06 FLEXIBLE HOSE CONNECTOR

A. Flexible stainless steel hoses shall be manufactured using type 304 stainless steel hose and braid with one fixed and one floating raised face carbon steel plate flange.

B. Sizes 2-1/2-inch and Smaller:
1. Threaded male nipples or copper sweat ends.
2. Grooved ends are acceptable in all sizes in grooved piping systems.
3. Weld ends are not acceptable.
4. Copper sweat end hoses for water service all copper or bronze construction.
5. Dielectric unions for dissimilar materials protection

C. Sizes 3-inch and Larger:
Flanged ends.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building
Planning
Engineering
Public Works
Fire
Traffic

2. Grooved ends are acceptable in all sizes in grooved piping systems.
3. Weld ends are not acceptable.
4. Dissimilar material connections not allowed.

D. Hose shall have close pitch annular corrugations for maximum flexibility and low stiffness. Tested hose stiffness at various pressures must be included in the submittals.

E. Hose shall be capable of continuous operation at 150 psi and system test pressure when installed in piping systems.

F. Hose shall be the same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required.

PART 3 EXECUTION

3.01 GENERAL

A. Do not install any equipment or pipe which makes rigid contact with the building.

B. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.

C. Correct, at no additional cost, all installations which are defective in workmanship or materials.

3.02 PREPARATION

A. Treat all isolators, including springs, hardware, and housing, with a corrosion protective coating of epoxy powder or electro galvanizing.

B. Coat steel frames exposed to weather with a rustproof metal primer.

C. Provide hot dipped galvanizing on steel frames as indicated on the plans for corrosion protection in severe conditions.

3.03 INSTALLATION

A. General:
1. Install isolation where indicated on the Drawings by type and location and where indicated below.
2. The assigned code number shall be marked on the isolators and bases to assure placement in the proper location.
3. Anchor isolator seismic housing baseplate to floor.
4. Rubber grommets and washers shall be provided to isolate the bolt from the building structure. Under no circumstances shall the isolation efficiency be destroyed when bolting the isolators to the building structure.

B. Type 5 – Base with Springs:
1. Service:
   a. Air Cooled Condensing Unit

3.04 SEISMIC RESTRAINTS

A. General:
1. Install and adjust seismic restraints so that the equipment, piping, and ductwork support is not degraded by the restraints.
2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment:
1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

2. Care must be taken so that the 1/4-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

C. Bracing of Pipes:
1. Branch lines may not be used to brace main lines.
2. Transverse bracing shall be at 40-feet maximum, except where a lesser spacing is indicated in the SMACNA Seismic Restraint Manual for bracing of pipes.
3. Longitudinal bracing shall be at 80-feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity to resist both the seismic load and the additional force induced by expansion and contraction.
4. Fuel oil, gas, cast iron pipe of all types, glass pipe and any other pipes joined with four band shield and clamp assembly shall be braced at 1/2 the spacings shown above.
5. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
6. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24-inches of the elbow or tee.
7. Branch lines may not be used to restrain main lines.
8. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
9. Subject to confirmation by field inspection, seismic bracing is not required on piping when the piping is supported by rod hangers and the hangers in the entire run are 12-inches or less in length from the top of the pipe to the supporting structure, hangers are detailed to avoid bending of the hangers and their attachments and provisions are made for piping to accommodate expected deflections.

D. Bracing of Ductwork:
1. Transverse restraints shall occur at 30-foot intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
2. Longitudinal restraints shall occur at 60-foot intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4-feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
3. Hanger straps must be positively attached to the duct within 2-inches of the top of the duct with a minimum of two number 10 sheet metal screws.
4. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
5. Walls, including gypsum board nonbearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide solid blocking around duct penetrations at stud wall construction.
6. Unbraced ducts shall be installed with a 6-inch minimum clearance to vertical ceiling hanger wires.

E. Suspended Equipment, Piping, and Ductwork Cable Method:
1. The cables shall be adjusted to a degree of slackness approved by the Structural Engineer.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

2. The uplift and downward restraint nuts and Mason type RW neoprene covered steel rebound washers for the Type 6 hangers adjusted so there is a maximum 1/4-inch clearance.
3. C-clamps for attachment to the bottom of I-beams must incorporate a restraining strap.

3.05 FIELD QUALITY CONTROL

A. Installation Report: Isolation manufacturer's representative shall confirm that all isolation is installed correctly and submit report stating that isolators are installed as shown on Shop Drawings, isolators are free to work properly, and that installed deflections are as scheduled and as specified.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Piping Markers
   2. Equipment Identification

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

A. Submit the following:
   1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
   2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
   3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Piping Markers:
   1. W.H. Brady
   2. Seton
   3. Marking Systems, Inc. (MSI)
   4. Other Manufacturers: Submit substitution request.

2.02 PIPING MARKERS

A. Label pipes with all-vinyl, semi-rigid plastic or strap-on labels.

B. For pipes O.D. smaller than 3/4-inch and for valve and fitting identification, use valve tag.

C. For sizes from 3/4 to 1-1/4-inch outside diameter, 1/2-inch letters, 8-inch marker width.

D. Identify pipe markers and color coded as follows with directional arrows.

HVAC SERVICE	PIPE MARKER *	BACKGROUND/TEXT COLOR
REFRIGERANT	REFRIGERANT SUCTION	YELLOW/BLACK
	REFRIGERANT LIQUID	YELLOW/BLACK
	REFRIGERANT HOT GAS	YELLOW/BLACK
	REFRIGERANT RELIEF VENT	YELLOW/BLACK
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		

2.03 EQUIPMENT IDENTIFICATION

A. Nameplates:
   1. Tag fan coil units with engraved nameplates.
   2. 1/16-inch thick, 3-inch by 5-inch laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
   3. Identify unit with equipment tag as shown on Drawings and area served.
   4. Label constructed from same material as equipment nameplates.

B. Equipment Nameplate Directory:
   1. Include Owner and Contractor furnished equipment.
      a. Pumps
      b. Air Handlers
      c. Terminal Units

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

d. Other Equipment Nameplates

2. List the following on the Nameplate Directory for each piece of equipment:
   a. Designation
   b. Model Number
   c. Location of Equipment
   d. Area Served or Function
   e. Disconnect Location
   f. Normal Position of HOA Switch

PART 3 EXECUTION

3.01 PIPING MARKERS

A. Unless recommendations of ANSI A13.1 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
   1. Every 20-feet along continuous exposed lines.
   2. Every 10-feet along continuous concealed lines.
   3. Adjacent to each valve, flange, and stub-out for future.
   4. On pipe before and after wall, floor, and ceiling penetrations.
   5. On pipe into and out of concealed spaces.
   6. Adjacent to changes in pipe direction.
   7. On each riser.
   8. Adjacent to each leg of a T.
   9. Locate conspicuously where visible. Position pipe labels on pipe to achieve the best visibility.
   10. Provide pipe identification (over insulation) for reclaimed water systems in accordance with current local codes and rulings.
   11. Apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above.

B. Apply arrow labels indicating direction of flow.

3.02 EQUIPMENT IDENTIFICATION

A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Pressure Testing of Piping and Ductwork Systems

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.

B. Owner Witness: Perform tests in the presence of the Owner's representative.

C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.

D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's representative, and the Engineer's representative need not occur simultaneously.

1.04 SUBMITTALS

A. Submit the following:
   1. Test Reports:
      a. Submit certificate of completion, inspection and test by authority having jurisdiction on required piping systems.
      b. Submit certificate of test approval by Owner's representative on all systems.
      c. For ductwork testing, submit the Test Report.
      d. Test report shall contain description of the testing procedure and results, including recommendation for any remedial actions needed.
      e. The Engineer's representative will record witnessed tests.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 GENERAL

A. Piping:
   1. Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties.
   2. Conduct tests with all valves but those used to isolate the test section 10 percent closed.

B. Ductwork: Test prior to connection to equipment and before applying insulation.

C. Leaks: Repair all leaks and retest until stipulated results are achieved.

D. Notification:
   1. Advise the Construction Manager 72 hours in advance of each test.
   2. Failure to so notify will require test to be rescheduled.

E. Testing Equipment: Provide all necessary pumps, gauges, connections, and similar items required to perform the tests.

3.02 TESTING REQUIREMENTS

A. Low Pressure Ductwork:
   1. Test all ductwork systems at 2-inch static pressure, using a Pacific Air Products Port-O-Lab or Rolok, or a McGill Airflow leak detective testing machine or approved equivalent.
   2. All ductwork testing shall be conducted in accordance with latest published version of the SMACNA HVAC Air Duct Leakage Test Manual.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3. Prior to testing verify that all low-pressure ductwork has been sealed to meet the SMACNA Seal Class C. for all joints.
4. Low pressure ductwork leakage shall be less than or meet the requirement of the following SMACNA Leakage Classes:
   a. Rectangular Metal – Class 24
   b. Round or Flat Oval – Class 12
5. Maximum allowable leakage is defined as CFM air leakage per 100 SF surface area of duct section tested.
6. All low pressure ductworks shall be tested.

B. Piping - General:
1. Test all piping as noted below, with no leaks or loss in pressure/vacuum for time indicated.
2. Repair or replace defective piping until tests are completed successfully:

HVAC Systems	Test Pressure	Test Medium	Test Duration
Refrigerant piping – R410A	450 psig**	Nitrogen	24 hours
Refrigerant piping – R134A	450 psig**	Nitrogen	24 hours
Refrigerant piping – R407C	450 psig**	Nitrogen	24 hours
VRF Systems – R410A	550 psig**	Nitrogen	24 hours
VRF Systems – R410A	500 microns**	Vacuum	24 hours
* The outer casing field welds at piping closures shall be field tested for leaks. Pressurize with compressed air at 15 psig and apply a soap solution and check for leaks. ** Or as recommended by equipment manufacturer.			

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Testing and Balancing of Air Systems
   2. Testing and Balancing of Miscellaneous Mechanical Equipment

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

A. Acceptable Testing and Balancing Firms:
   1. Air Balance Associates
   2. Airtest Company
   3. MacDonald Miller
   4. National Indoor Air Care
   5. Neudorfer Engineers

B. Other Firms: Submit substitution requests prior to bid date.

C. Other Firms: Submit substitution requests prior to bid date.

D. Testing and Balancing Firm Qualifications:
   1. The Contractor shall procure the services of an independent balance and testing agency, approved by the Architect, which specializes in the balancing and testing of plumbing, heating, ventilating, and air conditioning systems, to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems as herein specified.
   2. The testing agency shall provide proof of having successfully completed at least five projects of similar size and scope. Testing and balancing work shall be done under direct supervision of registered professional engineer who has been employed by the Agency a minimum of one year prior to start of project.
   3. Certification: The firm shall be Certified by National Environmental Balancing Bureau (NEBB).

E. Industrial Standards: Testing and Balancing shall conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
   1. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
   2. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
   3. ANSI:
      a. S1.4 Specifications for sound level meters.
      b. S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.

F. Instrument Certification: Instruments used shall be accurately calibrated and certified within six months of balancing and maintained in good working order.

G. Test Observation: If requested, the tests shall be conducted in the presence of the Architect or the Architect's representative.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

1.04 SUBMITTALS

A. Submit the following:
   1. Balancing Log – Existing Systems: Submit preliminary report indicating existing conditions prior to making any modifications to existing systems.
      a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
      b. Provide drawings identifying location of all outlets.
   2. Equipment Data Sheets – Existing Systems: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
   3. Balancing Log:
      a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
      b. Provide drawings identifying location of all outlets.
   4. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
   5. Additional Data: Submit additional data as provided by Associated Air Balance Council (AABC) Standard forms.
   6. Number of Copies: Submit six copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
   7. Instrument Certification: When requested, submit certificate of calibration for equipment to be used.

B. Record data on NEBB forms or forms approved by the Architect.

1.05 PROJECT CONDITIONS

A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. Adjust central equipment as required and restore all unmodified branches and outlets to original condition. Obtain existing system drawings from Owner and become familiar with extent and nature of existing systems.

B. Do not perform final testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and operating continuously as required.

C. Conduct air testing and balancing with clean filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.06 WARRANTIES

A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 PRODUCTS – NOT APPLICABLE

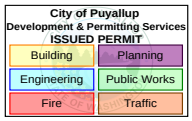
PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Balance to maximum measured flow. Deviation from specified values of ±10 percent at terminal device and ±5 percent at equipment, or mean sound level deviation of 15 decibels. Advise Engineer if deficiencies are generally noted to enable proper corrective actions.

3.02 AIR SYSTEMS

A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.



B. Preliminary:
   1. Identify and list size, type, and manufacture of all equipment to be tested including air outlets and inlets.
   2. Use manufacturer's ratings for equipment to make required calculations except where field test shows ratings to be impractical.

C. Distribution:
   1. Evaluate all building and room pressure conditions to determine adequate supply and return air conditions. Balance the building to be slightly positive to outdoors.
   2. Evaluate all building and room pressure conditions to determine adequate performance of the system to maintain temperatures without draft.
   3. Perform multipoint pitot traverses to confirm instrumentation, shaft tightness, fan operation, etc. Pitot traverses shall be performed using a Dwyer Series 400 air velocity meter only with applicable duct probe.
   4. Mark balancing dampers.

3.03 AUTOMATIC CONTROL SYSTEM

A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Testing organization shall verify all controls for proper calibration and list controls requiring adjustment by control system installer.

3.04 COORDINATION

A. Coordinate work with other trades to ensure rapid completion of the project.

B. Deficiencies noted during the course of air balancing in the mechanical installation shall be promptly reported to the Architect to allow corrective action to proceed.

C. Periodic review of progress shall be provided as requested.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Pipe Insulation
   2. Ductwork Blanket Insulation
   3. Accessories Piping
   4. Accessories Ductwork

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 29, Hangers, Supports and Anchors for HVAC

D. Section 23 31 01, HVAC Ducts and Casing – Low Pressure

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Prohibit insulating products from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
   2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723 or ASTM E84.
   3. Energy Codes: Local Building and Energy Codes govern where insulation performance requirements for thickness exceeds thickness specified.

B. Protection:
   1. Protect against dirt, water, chemical, or mechanical damage before, during, and after installation.
   2. Repair or replace damaged insulation at no additional cost.

C. Source Quality Control:
   1. Service: Use insulation specifically manufactured for service specified.
   2. Labeling: Insulation labeled or stamped with brand name and number.
   3. Insulation and accessories not to provide nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, not to react corrosively with equipment, piping, or ductwork, and asbestos free.

1.04 SUBMITTALS

A. Submit the following.
   1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pipe Insulation:
   1. Elastomeric:
      a. ArmacellAP Armaflex
      b. Rubatex
      c. K-Flex

B. Ductwork Blanket Insulation:
   1. Fiberglass:
      a. Johns Manville Microlite Type 100

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

2. Semi-Rigid Fiberglass:
   a. Johns Manville Micro-Flex
3. Elastomeric:
   a. Armacell Armaflex

2.02 PIPE INSULATION

A. Elastomeric:
1. Expanded closed cell with fitting covers and paintable surface.
2. Thermal Conductivity: 0.27 maximum K-factor at 75 degrees F mean temperature determined in accordance with ASTM C335.
3. Maximum Service Rating: 220 degrees F.
4. Color:
   a. Concealed Locations: Black
   b. Exposed Locations: White.

2.03 DUCTWORK BLANKET INSULATION

A. Fiberglass: 1.0 pcf nominal density, 0.25 per-inch maximum K-factor at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit.
1. Exposed: FSK facing (foil scrim Kraft) or vinyl - white appearance.
2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
3. Concealed without Vapor Barrier: Facing not required.

B. Semi-Rigid Fiberglass: 2.5 pcf nominal density, 0.24 per-inch maximum K-factor, at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit.
1. Exposed: FSK facing (foil scrim Kraft) or vinyl-white appearance.
2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
3. Concealed without Vapor Barrier: Facing not required.

C. Elastomeric: Expanded closed cell sheets, 0.27 per-inch maximum K-factor at 75 degrees F mean temperature and 220 degrees F minimum operating temperature limit.

2.04 ACCESSORIES PIPING

A. Adhesives:
1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
2. Fiberglass: Integral closure system.
3. Calcium Silicate: Benjamin Foster 30-36.
4. Elastomeric: Armacell 520 BLV.

B. Cements:
1. Insulating: Ramco Thermokote.
2. Heat Transfer: Chemax Tracit-300.

C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

D. Cloth Facing: Presized fiberglass cloth.

E. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F. Zeston Z-tape.

F. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

2.05 ACCESSORIES DUCTWORK

A. Adhesives:
1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
2. Fiberglass: Benjamin Foster 85-62, Design Polymerics 2501/2502

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3. Elastomeric: Armacell 520 BLV
4. Duct Insulation, Internal: Foster 85-62, Design Polymerics 2501/2502

B. Weld Pins: Duro-Dyne with NC-1 nylon stop clips

C. Cements:
1. Insulating: Ramco Thermokote.
2. Heat Transfer: Chemax Tracit-300

D. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

E. Mastic: Chicago Mastic:
1. Vapor Barrier: 17-475
2. Outdoor Mastic: 16-110 white

F. Cloth Facing: Presized fiberglass cloth

G. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F. Zeston Z-tape.

H. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

PART 3 EXECUTION

3.01 GENERAL

A. Workmanship:
1. Installation: Insulation installed in first class, neat professional manner.
2. Applicators: Employ by firm that specializes in insulation work.

B. Preparation: Surfaces of piping, ductwork, and equipment clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels not covered.

3.02 HVAC PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – HVAC Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Refrigerant Suction Hot Gas	1-1/4-inch and smaller	Elastomeric	1-inch	Note 3
Refrigerant Suction Hot Gas	1-1/2-inch and above	Elastomeric	1-1/2-inch	Note 3
Variable Refrigerant Flow (VRF) System Refrigerant Piping	1-inch and smaller	Elastomeric	1/2-inch	Note 4
Variable Refrigerant Flow (VRF) System Refrigerant Piping	1 1/8-inch and above	Elastomeric	1-inch	Note 4
Note 3: Elastomeric insulation not allowed over heat trace cable. Note 4: Or per VRF manufacturer installation recommendations.				

3.03 PIPING INSTALLATION

A. General:
1. Joints: Coat both sides of complete joining area with applicable adhesive.
a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
c. Multiple Layered Insulation: Joints staggered.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
3. Voids:
   a. Fill voids, chipped corners and other openings with insulating cement or material compatible with insulating material.
   b. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
4. Seal joints, seams, and fittings of metal watertight jackets at exterior locations.

B. Elastomeric Insulation:
1. Slit full length and snap around pipe.
2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
3. Do not stretch insulation to cover joints or fittings.
4. Seal joints in elastomeric insulation with adhesive.
5. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
6. Sealing joints with tape will not be allowed.

C. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
1. On Elastomeric Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

D. Unions, Mechanical Joints, Valves, etc.:
1. General:
   a. As specified for fittings.
   b. Minimum thickness same as specified for piping.
2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
4. Flanged Valves: Insulation with square corners.

3.04 DUCT INSULATION APPLIED LOCATIONS

A. General:
1. Provide external insulation with continuous vapor barriers unless specifically noted otherwise.
2. Internally line ductwork completely to grille or diffuser or to indicated terminal points. Dimension shown are net inside of liner.
3. Internally lined ductwork need not be externally insulated.
4. In addition to locations described in specification, internally line medium, low, return and exhaust air ductwork where shown on drawings.
5. Internal lining is not allowed downstream of final filters in systems serving inpatient healthcare facilities.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

B. Insulation Applied Location – HVAC Ductwork:

System	Location	Duct Type	Insulation Type	Thickness	Notes
Low Pressure Supply*	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	1-1/2-inch	
		Round	Internally Lined	1-1/2-inch	Note 3
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1-1/2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	3-inch	Note 3
	Under Slab Ductwork	All	Internally Lined	2-inch	
	Downstream of Air Terminal Units	All	Internally Lined	1-1/2-inch	Note 1 Note 3
	15-feet upstream and downstream of fans	All	Internally Lined	1-1/2-inch unless otherwise indicated	Note 3
Transfer Air	All	All	Internally Lined	1-inch	Note 3

* In addition to applied locations listed in this table, provide internally lined ductwork where indicated on drawings.
Note 1: Except ductwork downstream of terminal units serving patient care areas in hospitals
Note 2: Insulation not required on factory fabricated insulated housings and plenums (AHP).
Note 3: Where round or oval ductwork is indicated, provide double walled round/oval ductwork as specified in Section 23 31 02, HVAC Ducts and Casing-Medium Pressure, or provide internally lined rectangular ductwork with equivalent free area may be substituted.

3.05 DUCTWORK INSTALLATION

A. General:
1. Install in accordance with manufacturer's instruction.
2. Continuous vapor barrier. Coat with vapor barrier mastic and patch with facing or tape. Joints between insulation and access with vapor barrier mastic.
3. Insulation at access panels to be removable or attached to panel with edges of panel and opening reinforced with metal beading.

B. External Blanket Insulation:
1. Insulation secured to ductwork with 20-gauge snap wires 24-inches on center and at all joints.
2. Joints and seams lapped a minimum of 3-inches and sealed with jacket tape.

C. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep, and finish edges to maintain vapor barrier and to prevent damage to the insulation.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

3.06 FIELD QUALITY CONTROL

A. Field Test: Test and approve systems prior to installation of insulation.

B. Existing Insulation:
   1. Repair existing insulation damaged during construction.
   2. Make neat connections where new and existing insulation meet.
   3. Where existing piping, ductwork or equipment is removed, cover existing surfaces neatly to match existing.
   4. Where existing insulation is damaged or missing, notify the architect prior to performing to work.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Materials and Equipment
   2. Control Devices
   3. Connection to Existing Network
   4. BACnet Compatibility

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 93, Testing, Adjusting and Balancing

D. Section 23 21 13, Pipe and Pipe Fittings HVAC

1.03 QUALITY ASSURANCE

A. Provide control work by single company with specialists in the type of work required, so that only one control manufacturer is responsible for control and automation work for project.

B. Provide coordination with other contractors or subcontractors for work required by other trades for accomplishment of control work.

C. Prior to substantial completion, controls contractor must demonstrate to Owner that system is operating per the Specifications and final adjustments have been made as approved.

D. System, including components and appurtenances, configured and installed to yield a Mean Time Between Failure (MTBF) of at least 1,000 hours.

1.04 SUBMITTALS

A. Equipment Data: Submittals include complete data for materials, including field and system equipment.

1.05 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:
   1. General: Provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.
   2. Acceptance Test: Demonstrate compliance of completed control system with contract documents. Using approved test plan, physical and functional requirements of project demonstrated.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide thermostats where indicated to connect to existing building BMS system.

2.02 CONTROL DEVICES

A. Temperature Instruments:
   1. Room Temperature Sensors: Platinum RTD type with accuracy of ±0.4 degrees F at 70 degrees F; operating range 30 to120 degrees F; linear to DDC system; single point sensing element in wall-mounted ventilated enclosure with insulating back plate if mounted on exterior wall.
      a. Provide sensor with digital display.
      b. Sensor not to have user adjustment based on DDC programmed offset.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

2.03 CONNECTION TO EXISTING NETWORK

A. General: Communication between peer-to-peer DDC control panels via TCP/IP over the existing Ethernet system.

B. Provide software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing paging system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Room Thermostats and Room Sensors:
   1. Wall Thermostats and Room Sensors : Mount at height of 42 inches above finished floor.
   2. Provide insulating back on thermostats mounted on exterior walls.
   3. Provide one thermostat where indicated on control drawings. .
   4. Submit proposed locations for approval prior to preparing control drawings, where not shown or alternate location is proposed.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Copper Line Sets

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 25 00, HVAC Water Treatment

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Piping material and installation to meet requirements of the local building codes and serving utility requirements.

B. Grooved joint couplings and fittings products of a single manufacturer. Grooving tools by the same manufacturer as the grooved components.
   1. Castings used for coupling housings, fittings, valve bodies, etc., date stamped for quality assurance and traceability.

C. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, re-clean, and reconnect without additional expense to the Owner.

D. Correct damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.04 SUBMITTALS

A. Submit the Following:
   1. List of piping materials indicating the service it is being used for. Do not submit piping product data.
   2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.
   3. Certificate of completion
   4. Treatment Reports
   5. Radiant Floor Heating and Cooling Piping layout shop drawings.
   6. Radiant Floor Heating and Cooling Piping installation digital photographs.

B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

C. Other: Make certified welders' certificates available.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As indicated.

2.02 COPPER LINE SETS

A. Pipe: Soft (annealed) copper meeting the requirements of ASTM B1003 or B280.

B. Fittings: None. Tubing is continuous for entire system.

C. Length: As required to extend completely from indoor unit to outdoor unit. Packaged in a roll, capped and sealed.

D. Sizes: As required by equipment manufacturer for the capacity and length indicated. Not to exceed 2-inches nominal.

E. Insulation:
   1. Elastomeric, per section 230700, Insulation for HVAC.
   2. Where exposed to exterior, apply flexible, self-adhesive jacket.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

F. Service:
1. Refrigerant piping for mini-split air conditioners and heat pumps.

PART 3 EXECUTION

3.01 PREPARATION

A. Measurements, Lines and Levels:
1. Check dimension at the building site and establish lines and levels for work specified in this Section.
2. Establish inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.02 PIPING INSTALLATION

A. Support piping independently at apparatus so that its weight not carried by the equipment.

B. Run piping clear of tube cleaning or removal/replacement access area on coils, heat exchangers, chillers, etc.

C. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.

3.03 COPPER LINE SETS

A. Install per manufacturer's recommendations.

B. Not allowed where copper lines are exposed to view, only for use within concealed areas. Hard drawn copper tubing to be used in exposed areas.

C. Replace any soft copper lines that are damaged during installation.

3.04 ADJUSTING AND CLEANING

A. General:
1. Clean interior of piping before installation.
2. Flush sediment out of piping systems after installation before connecting mechanical equipment to the piping.
3. When placing the water systems in service during construction, each system cleaned by circulating a solution with 1000 ppm of trisodium phosphate for 24 hours, then drained, flushed and placed in service.
4. Clean strainers prior to placing in service.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Supports, Anchorage And Restraints
   2. Sheet Metal Ductwork
   3. Flexible Ducts

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping Equipment

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.

B. Regulatory Requirements:
   1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
   2. Ductwork and components UL 181 listed, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.04 SUBMITTALS

A. Submit the following:
   1. Provide catalog data on each product specified hereunder.
   2. Schedule of duct construction standards.
   3. Provide shop drawings showing materials and construction details for single wall housing plenum.
   4. Provide shop drawings showing construction details, support, and seismic restraint of ductwork distribution systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flexible Ducts:
   1. Thermaflex M-KE
   2. Gen Flex IMP-25S
   3. Other Manufacturers: Submit substitution request.

2.02 SUPPORTS, ANCHORAGE AND RESTRAINTS

A. General:
   1. Provide design for supports, anchorages, and seismic restraints for equipment when not shown on the Drawings.
   2. Supports, anchorage and restraints provided are required to resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
   3. Follow provisions in Section 23 05 48, Vibration and Seismic Control for HVAC Piping and Equipment for seismic restraints.
   4. Seismic restraints are not to introduce stresses in the ductwork caused by thermal expansion or contraction.
   5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

B. Suspended Ductwork: Provide seismic restraints in accordance with the latest edition of the SMACNA, Seismic Restraint Manual - Guidelines for Mechanical Systems for the seismic hazard level corresponding to the seismic zone in which the project is constructed.

C. Engineered Support Systems: Provide designs and details for the following support systems with the seal of a professional engineer registered in the State having jurisdiction:
   1. Supports and seismic restraints for suspended ductwork and equipment.
   2. Support frames for ductwork and equipment which provide support from below.
   3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.03 SHEETMETAL DUCTWORK

A. Fabricate from galvanized steel, unless noted otherwise.

B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers, and supports in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, Latest Edition.

C. Duct Classification: Ducts considered low pressure when design velocities are 2000 fpm or less and maximum static pressure is 2-inches wg positive or negative.
   1. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1/2-inch wg positive or negative.
      a. Supply ductwork downstream from terminal units.
      b. Supply, return or exhaust ductwork serving fans scheduled to operate at less than 1/2-inch wg
      c. Supply, return, or exhaust branch ductwork which serves one or two inlets/outlets.
   2. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1-inch wg positive or negative.
      a. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 1-inch wg On supply fans pressure drops for louvers, coils, clean filters, and sound traps may be deleted from scheduled fan static.
      b. Supply, return, or exhaust ductwork serving multiple duct branches where contractor can demonstrate that pressures will not exceed 1-inch wg positive or negative.
   3. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 2-inches wg, positive or negative.
      a. Supply, return, or exhaust ductwork serving fans scheduled to operate at pressures greater than 1-inch wg positive or negative.

D. Longitudinal seams on rectangular duct, Pittsburgh or Button punch snap lock. Snap lock seams for round duct may be used only on ducts classified for 1/2-inch wg. Longitudinal seams for round ducts using lap and rivet, spot weld, or fillet weld may be used only on ducts classified for statics 1-inch wg or less.

E. Joining and reinforcing systems manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA J, and Ductmate 25 is equivalent to SMACNA F.

F. Use of adjustable round elbows not permitted.

2.04 FLEXIBLE DUCTS

A. Flexible air duct with CPE or metal film liner permanently bonded to coated spring steel wire helix with 1-inch thick fiberglass insulation blanket covered with fiberglass reinforced metal film vapor barrier jacket.

B. Duct rated for 6-inch wg positive and 1-inch wg negative.

PART 3 EXECUTION

3.01 APPLIED LOCATIONS

A. Supply ductwork on downstream side of terminal box. Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

B. Supply Ductwork from Spin-In Fittings to Supply Outlet Collar Connection: Flexible duct, maximum 4-foot length.

C. Ductwork between Transfer Grilles: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

3.02 INSTALLATION

A. Ductwork:
   1. Seal traverse joints with an approved mastic during joining procedure or tape after joining to provide airtight duct system.
   2. Low pressure ductwork hanger and support systems in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Wire supports are not allowed.
   3. Provide supplementary steel for support of ductwork in shafts and between building structural members.
   4. Fabricate changes in direction to permit easy air flow, using full 1.5D radius bends or fixed turning vanes in square elbows. Radius elbows less than 1.5D radius, splitter vanes.
   5. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.
   6. Where pipe, structural member, or other obstruction passes through a duct, provide streamlined sheet metal collar around member and increase duct size to maintain net free area. Fit collar and caulk to make air tight.

B. Dampers: Install where shown and where necessary to complete final balancing of system. Install regulators as specified in Section 23 33 00, Air Duct Accessories for each specific project condition. Leave dampers locked wide open in preparation for balancing.

C. Extractors: Install behind supply grilles and registers where shown.

D. Flexible Connectors: Make connections to fans and other rotating equipment with flexible connectors with 2-inch minimum clearance between casing and ductwork. Not required on internally spring isolated units.

E. Spin-in Fittings:
   1. Install at branch takeoffs to outlets using round or flex duct.
   2. Connect to flexible duct with draw band strap and minimum of two wraps of duct tape.
   3. Leave dampers locked wide open.

F. Flexible Ducts:
   1. Make connections at ends using draw band strap and a minimum of 2 wraps of duct tape.
   2. Suspend center spans from structure above using wire as required by code. Connect to manufacturer's eyelet on jacket or use 1-inch wide galvanized steel strap with single loop at top and smooth edges.
   3. Suspending duct by laying it on the ceiling is prohibited.
   4. Avoid crimping flex duct. Changes in direction made using 2D radius. Duct connections to grilles, registers, and diffusers using less than 2D radius bends are not acceptable. Where space is constricted, use sheet metal elbows or Thermaflex Flex Boots (or equal).

3.03 FIELD QUALITY CONTROL

A. Coordination with Balance Agency:
   1. Provide services of a sheet metal person familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating sheet metal dampers.
   2. Install missing dampers required to complete final balancing.

END OF SECTION

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Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Split System Air Conditioning Unit
   2. Variable Refrigerant Flow (VRF) System

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 09 00, Instrumentation and Controls for HVAC

1.03 SUBMITTALS

A. Submit the following:
   1. Shop drawings showing details of construction, dimensions, arrangement of components, isolation, filters, etc.
   2. Product data showing performance data, standard items, and accessories, operating weight.
   3. Flow diagrams and pipe sizing for refrigerant systems.
   4. Operating and maintenance data.
   5. Testing Submittals:
      a. Provide test plan and test procedures for approval.
      b. Explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system.
      c. Test plan and test procedures demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.

1.04 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:
   1. General:
      a. Provide personnel, equipment, instrumentation, and supplies necessary to perform testing by a representative authorized by the manufacturer.
      b. Owner or Owner's representative will witness and sign off on acceptance testing.
   2. Acceptance Test:
      a. Demonstrate compliance of completed control system with contract documents.
      b. Use approved test plan, physical and functional requirements of project

B. Training:
   1. General:
      a. A representative authorized by the manufacturer conduct training courses for designated personnel in operation and maintenance of system.
      b. Orient training to specific system being installed under this contract.
      c. Provide training manuals for each trainee, with two additional copies provided for archival at project site.
      d. Manuals include detailed description of the subject matter for each lesson.
      e. Copies of audiovisuals delivered to Owner.
      f. Training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during normal first shift in effect at training facility.
      g. Notification of planned training given to the Owner's representative at least 15 days prior to the training.

City of Puyallup
Development & Permitting Services
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Building | Planning
Engineering | Public Works
Fire | Traffic

2. Operator's Training I:
   a. Teach at a convenient location for a period of one training day.
   b. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe general hardware architecture and functionality of system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Split System Air Conditioning Unit:
   1. Mitsubishi (Mr. Slim)

B. Variable Refrigerant Flow (VRF) System:
   1. Mitsubishi (City Multi).

2.02 SPLIT-SYSTEM AIR CONDITIONING UNIT

A. Indoor Unit:
   1. Description:
      a. Furnish complete unit including cabinet, wall mounting kit and accessories, refrigerant line set, fan and motor assembly, cooling coil and filter.
      b. Unit as scheduled on drawing, factory-tested and assembled, factory wired, refrigerant-to-air heat exchanger, fan/motor assembly, compressor, controls and safety devices, control circuit transformer, shipped in one piece with ARI certification and UL listing.
   2. Cabinet: 18 gauge steel, removable panels for access to components. Drain connection and return air filter racks.
   3. Fan and Motor:
      a. Assembly with a turbo fan direct driven by a single motor.
      b. Statically and dynamically balanced and run on a motor with permanently lubricated bearings.
      c. Fan consists of two speeds:
         1) High
         2) Low.
   4. Controls:
      a. Run wiring direct from the indoor unit to the controller with no splices.
      b. System capable of automatic restart when power is restored after power interruption
   5. Condensate Pump: Provide condensate pump when required; pipe drain to floor drain.

B. Outdoor Unit:
   1. Description:
      a. Provide air-cooled air conditioner (outdoor unit) designed for outdoor installation with factory-supplied supports, properly assembled, and tested at the factory.
      b. Completely weatherproofed and include compressor, condenser coils, condensing fans, motor, refrigerant reservoir, charging valve, controls, and a holding charge of R410A.
      c. Provide guards on condenser fans and coil guard.
   2. Compressors:
      a. Furnish hermetically sealed type with isolation and sound muffling.
      b. Overload and inherent winding thermostat protection to prevent burn out.
      c. Provide crankcase heater.
      d. Manifold multiple compressors for single joint connection on liquid and suction lines.
   3. Refrigeration Circuits: Back seating service valve and gauge ports in liquid and suction lines. Provided refrigerant filter-dryer.
   4. Condenser Fans and Motors: Direct driven propeller type fans with permanently lubricated motors.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

5. Controls:
   a. Provide high and low pressure cutouts, contactors and internal overload protection on motors.
   b. Provide low ambient operation to 20 degrees F outside to maintain condensing temperature on part load operation.
   c. Provide short cycle timer.

C. Controls Interface:
1. Equip with network port and network type data transfer interface with the DDC controller.
2. The following interface are required:
   a. BACnet protocol compatible with the system specified in Section 23 09 00, Instrumentation and Controls for HVAC.
   b. Alarms read to DDC controller.
   c. Analog signals read to DDC controller as a minimum:
      1) Space Temperature
   d. The following status signals be read to the DDC controller as a minimum:
      1) Occupied Cycle
      2) Unoccupied Cycle
      3) Warmup
      4) Override
      5) Supply Fan
      6) Compressors
      7) Heating/Cooling Operation

D. Controls Interface:
1. Equip with network port and network type data transfer interface with the system specified in Section 23 09 00, Instrumentation and Controls for HVAC.
2. Input and output points, setpoints and functions identified in the Sequences of Operation accessible to the DDC control system.
3. Refer to Section 23 09 93, Sequence of Operations for HVAC Controls.

E. Electrical:
1. Furnish starters, contactors and disconnects.
2. Arrange for single point electrical connections.
3. Provide power and control wiring.

F. Controls:
1. Provide wall-mounted locally programmable 7-day thermostats with automatic change over, fan on-auto switch, system off-auto switch, and individual set point for heating and cooling with backlit LCD display.
2. Provide minimum of four independent programmable temperature periods per day.
3. Provide retrievable error codes in the event of system abnormality/error.
4. Hand-held remote controller is not acceptable.

2.03 VARIABLE REFRIGERANT FLOW SYSTEM (VRF)

A. Indoor Unit – Wall Mounted:
1. Description:
   a. Wall mount ductless fan-coil unit.
   b. Furnish complete unit including the following:
      1) Cabinet
      2) Wall Mounting Kit and Accessories
      3) Refrigerant Line Set
      4) Electronic Expansion Valve
      5) Fan and Motor Assembly
      6) Cooling Coil

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

7) Condensate Drain Pan and Filter.

c. Unit as scheduled on drawing, factory-tested and assembled, factory wired, refrigerant-to-air heat exchanger, fan/motor assembly, compressor, controls and safety devices, control circuit transformer, shipped in one piece with ARI certification and UL listing.

2. Cabinet:
   a. 18 gauge steel, removable panels for access to components.
   b. Provide drain connection.
3. Fan and Motor:
   a. Evaporator fan assembly with one or two line-flow fan(s) direct driven by a single motor.
   b. Statically and dynamically balanced and run on a motor with permanently lubricated bearings.
   c. Fan consists of two speeds:
      1) High
      2) Low
4. Coil/Piping:
   a. Indoor Coil: Direct expansion type for nonferrous construction with smooth plate fins on copper tubing.
   b. Condensate Pan: Locate under coil.
   c. Insulate both refrigerant lines.
5. Filter: Filter return using a removable, washable filter.
6. Electrical:
   a. Furnish starters, contactors and disconnects.
   b. Arrange for single point electrical connection.
7. Condensate Pump:
   a. Where condensate pump is indicated, provide condensate pump with hard-wired electrical connection.
   b. Pipe drain to floor drain.

B. Indoor Unit – Ceiling Cassette:
1. Description:
   a. Ceiling-recessed cassette fan-coil unit.
   b. Furnish complete unit including cabinet, ceiling mounting kit and accessories, refrigerant line set, electronic expansion valve, fan and motor assembly, cooling coil, condensate drain pan, and filter.
   c. Unit as scheduled on drawing, factory-tested and assembly, compressor, controls and safety devices, control circuit transformer, shipped in one piece with ARI certification and UL listing.
2. Cabinet:
   a. Ceiling-recessed cassette constructed of 18 gauge steel, removable panels for access to components.
   b. Provide drain connection.
   c. Painted finish.
   d. Cabinet Panel: Provisions for a field installed filtered outside air intake.
   e. Branch ducting allowed from cabinet. Fix grille to bottom of cabinet allowing four-way blow.
3. Fan and Motor:
   a. Evaporator fan to have an assembly with one or two line-flow fan(s) direct driven by a single motor.
   b. Statically and dynamically balanced and run on a motor with permanently lubricated bearings.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

c. Consist of two speeds:
   1) High
   2) Low

4. Coil/Piping:
   a. Indoor Coil: Direct expansion type of nonferrous construction with smooth plate fins on copper tubing.
   b. Condensate Pan: Locate under coil.
   c. Insulate both refrigerant lines.
5. Filter: Return air filtered by means of an easily removable, washable filter.
6. Electrical:
   a. Furnish starters, contactors and disconnects.
   b. Arrange for single point electrical connection.
7. Condensate Pump:
   a. Provide internal factory-mounted condensate pump with hard-wired electrical connection.
   b. Pipe drain to floor drain.

C. Indoor Unit – Ceiling Exposed:
1. Description:
   a. Ceiling-suspended ductless fan-coil unit.
   b. Furnish complete unit including cabinet, ceiling mounting kit and accessories, refrigerant line set, electronic expansion valve, fan and motor assembly, cooling coil, condensate drain pan, and filter.
   c. Unit as scheduled on drawing, factory-tested and assembled, factory wired, refrigerant-to-air heat exchanger, fan/motor assembly, compressor, controls and safety devices, control circuit transformer, shipped in one piece with ARI certification and UL listing.
2. Cabinet: 18 gauge steel, removable panels for access to components. Provide drain connection.
3. Fan and Motor:
   a. Evaporator fan an assembly with one or two line-flow fan(s) direct driven by a single motor.
   b. Statically and dynamically balanced and run on a motor with permanently lubricated bearings.
   c. Consists of two speeds:
      1) High
      2) Low
4. Coil/Piping:
   a. Indoor coil direct expansion type for nonferrous construction with smooth plate fins on copper tubing.
   b. Condensate pan located under the coil.
   c. Insulate both refrigerant lines.
5. Filter: Return air filtered by a removable, washable filter.
6. Electrical:
   a. Furnish starters, contactors and disconnects.
   b. Arrange for single point electrical connection.
7. Condensate Pump: Where condensate pump is indicated, provide condensate pump with hard-wired electrical connection.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

D. Outdoor Unit:
   1. Description:
      a. Provide air-cooled heat pump (with heat recovery system for simultaneous heating and cooling) designed for outdoor installation with factory-supplied supports, properly assembled, and tested at the factory.
      b. Completely weatherproof and include compressor, condenser coils, condensing fans, motor, refrigerant reservoir, charging valve, controls, and a holding charge of refrigerant.
      c. Provide guards on condenser fans and coil guard. Power coated finish.
      d. Completely factory assembled, piped, wired, and tested.
      e. Both refrigerant lines insulated between the outside and inside units.
      f. Sound rating no higher than 63 dB(A).
      g. Modular in design and allow for side-by-side installation with minimum spacing.
      h. Provide accessories and kits required for a complete installation including field connection of heat pump units.
   2. Cabinet: The casing(s) fabricated of galvanized steel, bonderized and finished with baked enamel.
   3. Condenser Fans and Motors:
      a. Direct driven variable speed propeller type fans with permanently lubricated motors.
      b. Provide fans with a raised guard to prevent contact with moving parts.
      c. Outdoor Unit: Vertical discharge airflow.
   4. Refrigerant Circuits:
      a. Units hold a charge of R410A refrigerant.
      b. Include back seating service valve and gauge ports in liquid and suction lines.
      c. Provided refrigerant filter-dryer.
      d. Refrigeration circuit of the condensing unit consists of the following:
         1) Scroll Compressor
         2) Motors
         3) Fans
         4) Condenser Coil
         5) Electric Expansion Valve
         6) Solenoid Valves
         7) 4-Way Valve
         8) Distribution Headers
         9) Capillaries
         10) Filters
         11) Shut-Off Valves
         12) Oil Separators
         13) Service Ports
         14) Liquid Receivers
         15) Accumulators
   5. Outdoor Coil: Nonferrous construction with lanced or corrugated plat fins on copper tubing.
   6. Compressors:
      a. Furnish inverter driven scroll hermetic sealed compressor isolation and sound muffling.
      b. Overload and inherent winding thermostat protection to prevent burn out.
      c. Provide crankcase heater.
      d. Multiple compressors manifolded for single joint connection on liquid and suction lines.
      e. Capacity completely variable down to 16 percent of rated capacity.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

7. Controls:
   a. Provide high and low pressure cutouts, contactors and internal overload protection on motors.
   b. Provide low ambient operation to 0 degrees F outside to maintain condensing temperature on part load operation.
   c. Provide short cycle timer.
8. Warranty: Provide 5 year warranty on compressors.

E. VRF Controls:
1. Provide a complete, control system with operating and safety controls, consisting of remote controllers and centralized controllers.
2. Network together using a high-speed communication bus and wiring as recommended by manufacturer.
3. Provide control wiring and control power wiring for a complete and operational system.
4. Provide required controllers for stand-alone temperature sensors.
5. Controls network to support operation monitoring, scheduling, error email distribution, personal browsers, and online maintenance support.
6. Operator Workstation:
   a. Provide personal computer that performs data access, operator's commands, alarm management, requests for reports, file generation, diagnostics, and modifications.
   b. Control system not dependent on Operator Workstation for operation.
   c. Computer to be used for operator interface.
7. Room Thermostat:
   a. Provide locally programmable 7-day thermostats with automatic change over, fan on-auto switch, system off-auto switch, and individual set point for heating and cooling with backlit LCD display.
   b. Provide minimum of four independent programmable temperature periods per day.
   c. Provide error codes in the event of system abnormality/error.
   d. Provide one thermostat per unit unless otherwise indicated.
   e. Provide 10 percent spare stock to owner.
   f. Based on: Mitsubishi Deluxe MA Controller.
8. Centralized Controller:
   a. Capable of controlling a maximum of 50 indoor units with multiple outdoor units.
   b. Override remote controllers every 2 hours, system configuration, daily/weekly/annual scheduling, monitoring of operation status, error email notification, online maintenance tool, and malfunction monitoring.
   c. Provide basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or indoor units (collective batch operation) including on/off, operation mode selection (cool, heat, auto, dry, and fan), temperature setting, fan speed setting, airflow direction setting, error email notification, and online maintenance.
9. Power Supply: Provide power supply for controls from spare electrical circuits, including breakers, disconnects, transformers, and wiring.
10. Refer to Section 23 09 93, Sequence of Operations for HVAC Controls for required controls, control functions, and sequences of operation for controls.

F. Controls Interface:
1. Equip with network port and network type data transfer interface with the DDC controller.
2. The following interface required:
   a. BACnet protocol compatible with the system specified in Section 23 09 00, Instrumentation and Controls for HVAC.
   b. Alarms read to DDC controller.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

c. The following analog signals read to the DDC controller as a minimum: Space temperature.
d. The following status signals be read to the DDC controller as a minimum:
   1) Occupied Cycle
   2) Unoccupied Cycle
   3) Warmup
   4) Override
   5) Supply Fan
   6) Compressors
   7) Heating/Cooling Operation

G. Controls Interface:
   1. The packaged equipment controls equipped with a network port and network type data transfer interface with the system specified in Section 23 09 00, Instrumentation and Controls for HVAC.
   2. Input and output points, setpoints and functions identified in the Sequences of Operation accessible to the DDC control system.
   3. Refer to Section 23 09 93, Sequence of Operations for HVAC Controls.

PART 3 EXECUTION

3.01 SPLIT-SYSTEM AIR CONDITIONING UNIT

A. Installation:
   1. Install in location shown on the Drawings. Level unit and secure to structure.
   2. Make piping connections and unit installation per manufacturer's recommendations and installation guides.
   3. Size and run refrigerant piping between fan coil unit(s) and air-cooled condensing unit(s) per manufacturer's recommendations. Provide traps and double suction and/or discharge risers if recommended by the manufacturer.
   4. Insulate refrigerant piping as specified in Section 23 07 00, Insulation for HVAC.
   5. Pipe condensate pan to floor drain per manufacturers installation guide.
   6. Make refrigerant piping connections, install refrigeration accessories, and charge system. Provide additional refrigerant as required for proper operation at design capacities.

B. Start-up:
   1. General: Comply with manufacturer’s instructions.
   2. Install filters before operating unit.
   3. Insure proper refrigerant and airflow before operating unit compressor.

C. Provide interconnecting power and control wiring, routed in conduit from the outdoor unit to the indoor unit, and control panel thermostat. Where unit provided requires separate power connections to the indoor and outdoor units provide at no additional cost. Include branch circuit conduit, wiring, circuit breaker, terminations, etc. as required for complete system. Branch circuit serving indoor unit originates in same panelboard serving outdoor unit.

D. Testing and Adjusting/Performance Test: Except where initial unit operation clearly shows the performance meets or exceeds the requirements, test to show compliance. The manufacturer’s representative in the presence of the Engineer to perform tests.

3.02 VARIABLE REFRIGERANT FLOW SYSTEM

A. Installation:
   1. Install in location shown on the Drawings. Level unit and secure to structure. Provide secondary structural base where required to attached to structure. Provide vibration isolators where indicated.
   2. Make piping connections and unit installation per manufacturer's recommendations and installation guides.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3. Size and run refrigerant piping between fan coil unit(s), branch circuit controller(s) and condensing unit(s) per manufacturer's recommendations.
4. Insulate refrigerant piping as specified in Section 23 07 00, Insulation for HVAC.
5. Pipe coil drain pan to floor drain per manufacturers installation guide.
6. Provide secondary drain protection via a sensor in the drain pain overflow. Field wire interlock to shut down the unit upon sensing of moisture.
7. Make refrigerant piping connections, install refrigeration accessories, and charge system. Provide additional refrigerant as required for proper operation at design capacities.
8. Provide interconnecting power and control wiring.

B. Controls:
1. Install controls.
2. Provide devices, materials, equipment, software, wiring, interconnecting power, labor, and engineering necessary to achieve the Sequences of Operation described in Section 23 09 93, Sequence of Operations for HVAC Controls.

C. Start-up:
1. Comply with manufacturer’s instructions. Startup checklist to be provided by the manufacturer and completed by the contractor prior to startup.
2. Startup to be witnessed and signed off on by the manufacturer’s representative.
3. Install filters before operating unit.
4. Ensure proper refrigerant and airflow before operating unit compressor.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. The intent of Division 26, Electrical Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.

B. Include work specified in Division 26, Electrical and as indicated on Drawings. Include appurtenances, connections, fasteners, and accessories required to make a complete working system, whether indicated or not indicated.

C. Refer to Division 01, General Requirements.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

1.03 REFERENCES

A. The latest adopted revisions of the publications listed below apply to these Specifications as referenced:

1.	IBC	International Building Code
2.	NEC	National Electrical Code
3.	NFPA	National Fire Protection Association
4.	NEMA	National Electrical Manufacturers Association
5.	NECA	National Electrical Contractors Association
6.	ANSI	American National Standards Institute
7.	IEEE	Institute of Electrical and Electronic Engineers
8.	UL	Underwriters Laboratories
9.	WAC	Washington Administrative Code

1.04 SYSTEM DESCRIPTION

A. Ground Systems:
   1. Provide complete ground systems indicated.
   2. Include conduit system, tmotors, and miscellaneous grounds required by Contract Documents and by applicable codes.

B. System Identification:
   1. Clearly identify elements of the Project electrical system to indicate the loads served, or the function of each item of equipment, connected under this work.
   2. Comply with requirements of Division 26, Electrical, and with applicable codes.

C. Drawings:
   1. Drawings are diagrammatic. They do not show every offset, bend, tee, or elbow, which may be required to install work in the space, provided and avoid conflicts with other construction.
      a. Prior to installing work, take field dimensions, and note conditions available for, installation.
      b. Follow the Drawings as closely as practical to do so, and install additional bends, offsets, and elbows where required by installation conditions.
         1) Additional offsets, bends, and other connectors are subject to approval by Project Engineer.
         2) Install additional offsets, bends, and other connectors without additional cost to Owner.
      c. The right to make any reasonable changes in outlet location prior to roughing in is reserved to the Owner's Representative.

City of Puyallup
Development & Permitting Services
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Building | Planning
Engineering | Public Works
Fire | Traffic

2. Circuits:
   a. Do not change branch circuiting indicated; nor combine homeruns, without Engineer's prior approval.
   b. Do not combine or change feeder runs.
3. Circuit Conductors:
   a. Cross or hash marks on conduit runs indicate quantity of No. 12 copper branch circuit conductors, unless otherwise noted.
   b. Where such marks do not appear, provide quantity of circuit conductors to the outlets shown to perform the control or circuiting indicated.
   c. Include ground, travelers, and switch legs required by the circuiting arrangement indicated.
   d. Provide a dedicated neutral conductor with each circuit. Do not use a shared neutral conductor between phases unless, requested or directed.

1.05 SUBMITTALS

A. Comply with Division 01, General Requirements.

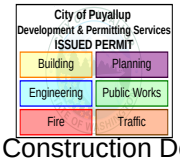
B. Contractor Responsibilities:
   1. Submit submittals one time and in proper order.
   2. Ensure equipment will fit in the space provided.
   3. Deviations from the Drawings and Specifications specifically noted in the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.

C. Shop Drawings and Equipment Data:
   1. Combine electrical shop drawings and equipment data in Submittal binders.
   2. Include in Submittal binders:
      a. Complete index of materials and equipment as required by Specifications to be documented by submittals.
      b. Fully describe equipment furnish per manufacturer's detailed specifications.
      c. All deviations from the Drawings and Specifications, noted on the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.

D. Installation Drawings:
   1. Submit prior to starting installation.
   2. Show outlets, devices, terminal cabinets, conduits, wiring, and connections required for the complete system described.

E. Record Drawings:
   1. Keep record drawings up to date as the work progresses.
   2. Show changes, deviations, addendum items, change orders, corrections, and other variations from the Contract Drawings.
   3. Keep record drawings at the jobsite and available for the Architect's review.
   4. At the completion of the work, incorporate all deviations from the installation drawings to indicate as-built conditions.

F. Operation and Maintenance Data:
   1. As specified in Division 01, General Requirements.
   2. Description of system.
   3. Operating Sequence and Procedures:
      a. Step-by-step procedure for system start-up, including a pre-start checklist.
         1) Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
      b. Detailed instruction in proper sequence, for each mode of operation (i.e., day-night, staging of equipment).



c. Emergency Operation:
1) If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under those conditions.
2) Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components or other unusual condition.
d. Shutdown Procedure:
1) Include instructions for stopping and securing the equipment after operation.
2) If a particular sequence is required, give step-by-step instructions in that order.

4. Preventive Maintenance:
a. Schedule for preventive maintenance.
1) State the recommended frequency of performance of each preventive maintenance task such as cleaning, inspection, and scheduled overhauls.
b. Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
c. Inspection: If periodic inspection of equipment is required for operation, cleaning, or other reasons, indicate the items to be inspected and give the inspection criteria.
d. Provide instructions for lubrication and adjustments required for preventive maintenance routines. Identify test points and given values for each.
5. Manufacturers' Brochures:
a. Include manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views, and renewal parts lists.
b. Clearly define manufacturers' standard brochures so that the information applying to the actual installed equipment.
6. Results of performance testing, as specified in PART 3 of this Section.

G. Submittals Procedures:
1. Review and recommendations by the Architect or Engineer are not to be construed as change authorizations.
2. Either if discrepancies are discovered between the materials or equipment submitted, and the Contract Documents, prior to or after the data is processed, the Contract Documents govern.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Provide work and materials conforming to:
a. Local and State codes.
b. Federal and State laws and regulations.
c. Other applicable laws and regulations.
2. Obtain and pay for all permits, licenses, and inspection certificates required by authorities having jurisdiction.
3. Pay any other fees required by governing authorities for work of this Division.

B. Install only electrical products listed by a recognized testing laboratory, or approved in writing by the local inspection authority as required by governing codes and ordinances.

1.07 SITE VISITATION

A. Visit the site prior to bidding and become familiar with existing conditions and other factors which may affect the execution of the work. Complete coordination of installation of equipment with prior bid packages previously issued. Include related costs in the initial bid proposal.

1.08 COORDINATION

A. Coordinate Work of This Division with all other trades to ensure proper installation of electrical equipment.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

1. Review Drawings of other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, and other possible impediments to electrical work.
2. Report potential conflicts to the Architect prior to rough-in.
3. Proceed with rough-in following Architect's directives to resolve conflicts.
4. Architectural Drawings govern.

B. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor's responsibility includes:
1. Coordination of the equipment to fit into the available space.
2. Access routes through the construction.

C. Layout Drawings:
1. Equipment arrangement shown on Drawings is diagrammatic to indicate general equipment sizing and spatial relationship. Include, as part of distribution equipment submittal, a scaled floor plan, which includes equipment shown with their submitted sizes. Include all feeder conduit routing, both aboveground and underground, including termination points at equipment. Submit for Engineer's review prior to commencing work.
2. Provide additional wiring details at switchboards, motor control centers, and other areas where work is of sufficient complexity to warrant additional detailing for coordination.
3. Submit layout drawings for approval prior to commencing field installation.

D. Where electrical connections are required for equipment provided as Work of other Divisions, coordinate rough in and wiring requirements for that equipment with its supplier and installer prior to commencing work. Notify Architect and Engineer of any discrepancies between the actual rough in and wiring requirements, and those identified on Drawings for resolution prior to installation.

E. Arrange raceways, wiring, and equipment to permit ready access to switches, motors, and control components.
1. Keep doors and access panels clear.

F. Coordinated Shop Drawings.
1. Prepare in two-dimensional format.
2. Include but are not limited to:
a. Superplot plans of above ground work with a colored overlay of all trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, grounding systems, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.

1.09 CHANGE ORDERS

A. Supplemental cost proposals by the Contractor accompanied with a complete itemized breakdown of labor and materials. At the Architect's request, make available estimating sheets for the supplemental cost proposals. Separate and allocate labor for each item of work.

1.10 WARRANTY

A. Provide a written warranty covering the work of this Division as required by the General Conditions.
1. Incandescent Lamps: Excluded from this warranty.

B. Apparatus:
1. Free of defects of material and workmanship and in accord with the Contract Documents.
2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.
3. Operate at full capacity without objectionable noise or vibration.

C. Include in Contractor's warranty for Work of Division 26, Electrical system damage caused by failures of any system component.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 2 PRODUCTS

2.01 GENERAL

A. Where specified materials or methods conflict with applicable codes, the more stringent requirement applies.

B. Provide apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

C. Ensure that entire electrical system operates at full capacity without objectionable noise or vibration.

D. Materials and Equipment:
   1. Use materials and equipment that are:
      a. New
      b. Quality meeting or exceeding specified standards.
      c. Free of faults and defects.
      d. Conforming to Contract Documents.
      e. Of size, make, type, and quality specified.
      f. Suitable for the installation indicated.
      g. Manufactured in accordance with NEMA, ANSI, UL, or other applicable standards.
      h. Otherwise as specified in Division 01, General Requirements.
   2. Equipment not meeting all requirements will not be acceptable, even though specified by name.
   3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer.
      a. Component parts of the entire system need not be products of same manufacturer.
   4. Basis of Design:
      a. Consider the Basis of Design equipment scheduled or specified by performance or model number.
      b. If other equipment is provided in lieu of the Basis of Design equipment, assume responsibility for all changes and costs which may be necessary to accommodate this equipment, including, but not limited to:
         1) Different sizes and locations for connections.
         2) Different dimensions.
         3) Different access requirements.
         4) Other differences.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Provide a complete properly operating system for each item of equipment specified.
   2. Install materials in a neat and professional manner.
   3. Comply with equipment manufacturer's written instructions, the best industry practices, and the Contract Documents.
   4. Comply with latest published NECA Standard of Installation, and provide competent supervision.

B. Clarification:
   1. Where there is a conflict among manufacturer's instruction, best practice, and the Documents, request clarification from the Architect prior to rough-in.
   2. Architect's decision will be final.
   3. Remove and correct work installed without clarification at no cost to the Owner.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

C. Existing concrete, block, or brick walls are considered not accessible and may require use of Surface Mounted Raceway (SMR) if existing concealed raceway and device boxes are not available for reuse or do not meet the intent of the design (i.e., proximity to egress path, point of use, etc.). Coordinate route and installation where SMR is required with the Architect/Engineer prior to rough-in. Responsible for reinstalling SMR routed without such prior approval to the Architect's satisfaction.

D. Existing stud walls (wood or metal) with or without blocking with plaster, plasterboard, or paneling finish are considered accessible with accessible ceiling, attic, tunnel, or crawl space above, below, or adjacent. Remove, patch, and repair finished surface as required to conceal rough in for new device locations. If it is determined that a specific instance will not permit concealment of rough-in due to obstructions such as beams, headers, and other structural elements, prior approval before rough-in from the Architect is required.

3.02 INSTALLATION IN RATED CONSTRUCTION

A. Install intumescent material around ducts, conduits, and other electrical elements penetrating rated construction.

B. Comply with firestop materials manufacturer written instructions to prevent spread of smoke or fire through sleeves or block-outs penetrating rated fire barriers.

C. Provide firestop materials specified in Division 07, and as follows:
   1. Capable of passing a 3-hour test per ASTM E-814 (UL 1479).
   2. Consisting of material capable of expanding nominally eight times when exposed to temperatures of 250 degrees F-350 degrees F.
   3. An alternate method utilizing intumescent materials in caulk or putty complying with Division 07, Thermal and Moisture Protection Section, "Through-Penetration Firestop Systems" may be used.

3.03 NOISE CONTROL

A. Minimize transmission of noise between occupied spaces.

B. Outlet Boxes:
   1. Do not install outlet boxes on opposite sides of partitions back to back.
   2. Do not use straight through outlet boxes, except where indicated.

C. Conduit:
   1. Route conduit along corridors or other "noncritical" space to minimize penetrations through sound rated walls, or through non-sound-rated partitions between occupied spaces.
   2. Grout solid and airtight all penetrations through sound rated partitions.
   3. Use flexible connections or attachments between independent wall structures.
      a. Do not rigidly connect (i.e., bridge) independent wall structures.

D. Do not install contactors, transformers, starters, and similar noise-producing devices on walls that are common to occupied spaces, unless otherwise indicated.
   1. Where such devices are indicated to be mounted on walls common to occupied spaces, use shock mounts, or otherwise isolate them to prevent the transmission of noise to the occupied spaces.

E. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3.04 EQUIPMENT CONNECTIONS

A. General:
   1. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices, and labor necessary for a finished working installation.
   2. Verify the location and method for connecting to each item of equipment prior to roughing-in.
   3. Check the amperage, maximum overcurrent protection, voltage, phase, and similar attributes of each item of equipment before rough in and connection.

B. Motor Connections:
   1. Make motor connections for the proper direction of rotation.
   2. Minimum Size Flex for Mechanical Equipment: 1/2-inch; except at small control devices where 3/8-inch flex may be used.
   3. Exposed Motor Wiring: Jacketed metallic flex with minimum 6-inches slack loop.
   4. Do not test run pump motors until liquid is in the system.

C. Control devices and wiring relating to the HVAC systems are furnished and installed under Division 23, HVAC; except for provisions or items indicated in Division 26, Electrical Drawings and Specifications.

3.05 EQUIPMENT SUPPORT

A. Minimum Support Capacity:
   1. Provide fastening devices and supports for electrical equipment, luminaires, panels, outlets, and cabinets capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure.

B. Support all junction boxes, pull boxes, or other conduit terminating housings located above the suspended ceiling from the floor above, roof, or penthouse floor structure to prevent sagging or swaying.

C. Conduits:
   1. Support suspended conduits 1-inch and larger from the overhead structural system with metal ring or trapeze hangers and threaded steel rod having a safety factor of four.
   2. Conduits smaller than 1-inch installed in ceiling cavities, may be supported on the mechanical system supports when available space and support capacity has been coordinated with the subcontractor installing the supports.
   3. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.

D. Powder actuated or similar shot-in fastening devices will not be permitted for any electrical work except by special permission from the Architect.

3.06 ALIGNMENT

A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines.

B. Install distribution equipment and electrical enclosures fitted neatly, without gaps, openings, or distortion.

C. Properly and neatly, close unused openings with approved devices.

D. Fit surface panels, devices, and outlets with neat, appropriate, trims, plates, or covers without overhanging edges, protruding corners, or raw edges.

3.07 CUTTING AND PATCHING

A. General:
   1. Comply with Division 01, General Requirements.
   2. Restore to original condition new or existing work cut or damaged by installation, testing, and removal of electrical Work.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3. Patch and finish spaces around conduits passing through floors and walls to match the adjacent construction, including painting or other finishes.
4. Clean up and remove all dirt and debris.

B. Make additional required openings by drilling or cutting. Use of jackhammer is prohibited.

C. Cut oversize fill holes so that a tight fit is obtained around the objects passing through.
1. In rated construction, comply with Division 07, Thermal and Moisture Protection.

D. Obtain Architect's permission and direction prior to piercing beams or columns.

E. Where alterations disturb lawns, paving, walks, and other permanent site improvements, repair and refinish surfaces to condition existing prior to commencement of work.

3.08 PROTECTION OF WORK

A. Protect electrical work and equipment installed under this Division against damage by other trades, weather conditions, or any other causes.
1. Equipment found damaged or in other than new condition will be rejected as defective.

B. Keep switchgear, transformers, panels, luminaires, and electrical equipment covered or closed to exclude dust, dirt, and splashes of plaster, cement, paint, or other construction material spray.
1. Equipment not free of contamination is not acceptable.

C. Provide enclosures and trims in new condition, free of rust, scratches, and other finish defects.
1. If damaged, properly refinish in a manner acceptable to the Architect.

3.09 UNINTERRUPTED SERVICE

A. Maintain electrical service to all functioning portions of the building throughout construction.

B. Pre-arrange with Owner outages necessary for new construction.
1. Comply with Division 01, General Requirements.
2. Apply for scheduled shutdowns minimum 4 weeks prior to time needed and reconfirm a minimum of 72 hours prior to time needed.
3. Contractor is liable for any damages resulting from unscheduled outages or for those not confined to the pre-arranged times. Damages include costs incurred by the Owner and by the Owner's tenants.

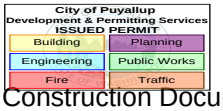
C. Maintain signal and communication systems and equipment in operation at all times.
1. Outages of these systems shall be treated the same as electrical power outages.

D. Maintain telephone services in accordance with Division 01, General Requirements.

3.10 DEMOLITION AND SALVAGE

A. General:
1. Remove or relocate all electrical wiring, equipment, luminaires, etc., as may be encountered in removed or remodeled areas in the existing construction affected by this work.
2. Disconnect electrical service to hard-wired equipment scheduled for removal under other Divisions of Work.
3. Wiring which serves usable existing outlets restored and routed clear of the construction or demolition.
4. Safely cut off and terminate wiring abandoned and removed to leave site clean.

B. Reuse of Existing:
1. Existing concealed conduits in good condition may be reused for installation of new wiring where available.
2. Existing undamaged, properly supported surface conduits may be reused where surface conduits are called for, if the installation meets all workmanship requirements of the Specifications.



3. Where new wiring is added or existing wiring disturbed in existing branch circuit raceways, existing wires replaced with new.

C. Salvage and Disposal:
1. Removed materials, not containing hazardous waste, not scheduled for reuse shall become the property of the Contractor for removal from the site, except for those items specifically indicated on the Demolition Drawings for salvage or reuse.
2. Materials containing, or possibly containing, hazardous waste identified for removal and disposal by the Owner's Hazardous Waste Contractor.
3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.
4. Salvage properly operating circuit breakers from panels scheduled for removal and use to replace faulty or inadequate breakers in existing panels scheduled to remain.

3.11 COMPLETION AND TESTING

A. General:
1. Comply with Division 01, General Requirements.

B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults and unintentional grounds.
1. Schedule system tests so that several occur on the same day.
2. Coordinate testing schedule with construction phasing.
3. Conduct tests in the presence of the Architect or its representative.
4. Notify Architect of tests 48 hours in advance.

C. Engage a journeyman electrician with required tools to conduct equipment tests. Arrange to have the equipment factory representative present for those tests where the manufacturer's warranty could be impacted by the absence of a factory representative.

D. Perform tests per the requirements of each of the following systems:
1. Low Voltage Distribution System

E. Provide a written record of performance tests and submit with operation and maintenance data.

END OF SECTION

City of Puyallup
Development & Permitting Services
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Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Conductors - 600V
   2. Power Limited Wiring
   3. Conductors - Fire Pump Circuits
   4. MC Branch Circuit Cable
   5. Connectors - 600V and Below

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 26, Grounding and Bonding for Electrical Systems

D. Section 26 05 33, Raceways and Boxes for Electrical Systems

E. Section 26 05 53, Identification for Electrical Systems

F. Section 26 05 80, Electrical Testing

1.03 REFERENCED STANDARDS

A. ASTM: American Society for Testing and Materials:
   1. ASTM B 3 — Soft or Annealed Copper Wire
   2. ASTM B 8 — Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
   3. ASTM B 33 — Tinned Soft or Annealed Copper Wire for Electrical Purposes

B. ICEA: Insulated Cable Engineers Association:
   1. S-95-658 — Non-shielded 0-2 kV Cables

C. IEEE: Institute of Electrical and Electronic Engineers:
   1. IEEE 383 — Type Test of Class IE Electric Cables, Field Splices, and Connections

D. UL: Underwriters Laboratories:
   1. UL 44 — Rubber-Insulated Wires and Cables
   2. UL 83 — Thermoplastic-Insulated Wires and Cables
   3. UL 1277 — Type TC Power and Control Tray Cable

1.04 SUBMITTALS

A. Submit product data for the following materials:
   1. Single conductor 600V power and control conductors.
   2.

B. Submittals of the following materials consist only of a listing of the manufacturer's name and the applicable catalog numbers of the items to be utilized:
   1. Connectors
   2. Branch Circuit Conductor Splices
   3. Splices with Compression Fitting and Heat-Shrinkable Insulator

C. Submit cable test data per testing requirements of PART 3.

1.05 QUALITY ASSURANCE

A. Copper Conductors: Indicated sizes considered minimum for ampacities and voltage drop requirements.

B. Conductors for special systems as recommended by the equipment manufacturer except as noted.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

C. Deliver conductors to the job site in cartons, protective covers, or on reels.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conductors - 600V Copper:
   1. Cerro
   2. Encore
   3. Essex
   4. GeneralOkonite
   5. Southwire
   6. Or Approved Equal

B. Conductors – 600V Aluminum
   1. Encore
   2. Southwire
   3. Stabiloy

C. Connectors - 600V and Below:
   1. Burndy
   2. Anderson
   3. Or approved equal

2.02 CONDUCTORS – 600V

A. Type:
   1. Copper: 12 AWG minimum size unless noted otherwise. 12 AWG and 10 AWG, solid or stranded, 8 AWG or larger, Class B concentric or compressed stranded.
   2. Aluminum: Not allowed.

B. Insulation:
   1. THHN/THWN-2 for conductors 6 AWG and smaller.
   2. XHHW-2 for conductors 4 AWG and larger.

2.03 POWER LIMITED WIRING

A. Copper, stranded or solid as recommended by the system manufacturer.

B. Insulation appropriate for the system and location used.

2.04 CONNECTORS – 600V AND BELOW

A. Branch Circuit Conductor Splices:
   1. Twist-on wire connectors:
      a. 3M Insulated Electrical Spring Connector (312/512)
      b. Ideal Industries Wing-Nut,
      c. Buchanan B-Cap.
   2. Push in self-locking type connectors, WAGO.

B. Cable Splices:
   1. Compression tool applied sleeves, Kearney, Burndy, or equivalent with 600V heat shrink insulation.
   2. Submit proposed splice location to the Engineer for review, except where indicated on the plans

C. Terminator Lugs for Stranded Wire:
   1. 10 AWG Wire and Smaller: Spade flared, tool applied.
   2. 8 AWG Wire and Larger: Compression tool applied.
   3. Setscrew type terminator lugs furnished as an integral part of distribution equipment, switches and circuit breakers will be acceptable.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 3 EXECUTION

3.01 CONDUCTORS

A. Pulling compounds may be used for pulling conductors. Clean residue from the conductors and raceway entrances after the pull is made.

B. Pulleys or Blocks:
   1. Use for alignment of the conductors when pulling.
   2. Pulling in accordance with manufacturer's specifications regarding pulling tensions, bending radii of the cable, and compounds.

C. Make up and insulate wiring promptly after installation of conductors. Do not pull wire in until bushings are installed and raceways terminations are completed. Do not pull wire into conduit embedded in concrete until after the concrete poured and forms stripped.

D. Provide a dedicated neutral conductor with each branch circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.

E. For remodel work or where shared neutrals are used by equipment such as systems furniture, provide a breaker handle tie as required for the phases sharing the neutral conductor.

3.02 CONNECTORS

A. Terminate control and special systems with a tool applied spade flared lug when terminating at a screw connection.

B. Screw and bolt type connectors made up tight and retightened after an 8-hour period.

C. Apply tool applied compression connectors per manufacturer's recommendations and physically checked for tightness.

3.03 COLOR CODING

A. Color code secondary service, feeders, and branch circuit conductors. Phase color code to be consistent at feeder terminations, A-B-C left-to-right, A-B-C top-to-bottom, or A-B-C front-to-back. Color code is as follows:

120/240V 208Y/120V	Phase	480V 480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray*
Green	Ground**	Green
* or white with colored (other than green) tracer		
**Ground for isolated ground receptacles green with yellow tracer.		

B. Use solid color compound or solid color coating for 12 AWG and 10 AWG branch circuit conductors and neutral sizes.

C. Phase conductors 8 AWG and larger color code using one of the following:
   1. Solid color compound or solid color coating.
   2. Stripes, bands, or hash marks of color specified above.
   3. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Apply tags to cable stating size and insulation type where cable markings are tape covered.

D. Switch legs, travelers, etc., consistent with the phases to which, connected or a color distinctive from that listed.

E. Color-coding of the flexible wiring system conductors and connectors.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

F. For modifications and additions to existing wiring systems, conform color-coding to the existing wiring system.

3.04 FIELD TESTING

A. 600V Rated Conductors: Test for continuity. Perform insulation resistance test for conductors 100A and larger, after installation and prior to termination. Tests to be performed at 1,000V DC, and record and maintain the results, in tabular form, clearly identifying each conductor tested.
   1. Replace cables when test value is less than 1 megohms.
   2. Cable test submittal include results, equipment used, and date.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Ground Conductors
   2. Connectors
   3. Ground Pads
   4. Ground Rods

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 00, Common Work Results for Electrical

D. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 80, Electrical Testing

G. Section 26 24 16, Panelboards

H. Section 26 27 26, Wiring Devices

I. Section 26 29 00, Motor Controllers

1.03 QUALITY ASSURANCE

A. Provide complete ground systems as indicated. Include conduit system, motors, and miscellaneous grounds required.

B. Provide an insulated ground conductor in every conduit or raceway containing power conductors.

C. Continue existing system as specified herein and shown on the Drawings.

1.04 RECORD DRAWINGS

A. Include all grounding system components with record documents to indicate as-built conditions, including locations of embedded grounding conductors and below-grade components.

PART 2 PRODUCTS

2.01 GROUND CONDUCTORS

A. Green insulated copper for use in conduits, raceways, and enclosures.

B. Bare copper for ground grids and grounding electrode systems.

2.02 CONNECTORS

A. Cast, set screw, or bolted type.

B. Form poured, exothermic welds.

C. Grounding lugs where provided as standard manufacturer’s items on equipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Grounding Conductors: Sized in accordance with Article 250, Tables 250.66 and 250.122 of the National Electrical Code.

B. Grounding Conductor Connectors: Make up tight, located for future servicing, and ensure low impedance.

C. Plug-in Receptacles: Bonded to the boxes, raceways, and grounding conductor.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3.02 EQUIPMENT

A. Provide separate green insulated equipment ground conductor in non-metallic and flexible electrical raceways.

B. Ground controls, motors, disconnect switches, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, buses, etc., for this purpose.

C. Provide grounding bushings on feeder conduit entrances to panels and equipment enclosures and bond bushings to enclosures with minimum 10 AWG conductor. Connect the equipment ground to the building system ground. Use the same size equipment ground conductors as phase conductors, up through 10 AWG.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Hangers
   2. Pipe Straps
   3. Support of Open Cabling
   4. Rooftop Conduit Supports

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 33, Raceways and Boxes for Electrical Systems

D. Section 26 24 16, Panelboards

1.03 REFERENCED STANDARDS

A. International Building Code (IBC)

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

PART 2 PRODUCTS

2.01 HANGERS

A. Kindorf B-905-2A Channel, H-119-D washer, C105 strap, minimum 1/2-inch rod with ceiling flange, or approved equal.

2.02 PIPE STRAPS

A. Two-hole galvanized or malleable iron.

2.03 SUPPORT OF OPEN CABLING

A. Support of Open Cabling: Label NRTL for support of Category 16 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide electrical equipment supports.

B. Install vertical support members for equipment, straight and parallel to building walls.

C. Provide independent supports to structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over furred or suspended ceilings.

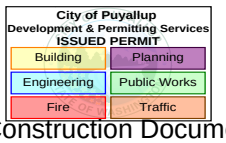
D. Do not use other trades' fastening devices to support electrical equipment materials or fixtures.

E. Do not use supports and/or fastening devices to support other than one particular item.

F. Support conduits within 18-inches of outlets, boxes, panels, cabinets, and deflections.

G. Provide complete seismic anchorage and bracing for the vertical and lateral restraint of conduit, cable trays, bus ducts, and electrical equipment as required by IBC Chapter 6 and the most recent version of the SMACNA Seismic Restraint Manual for Seismic Hazard Level (SHL) A.

H. Submit shop drawings of bracing systems to the Architect for review and bear the seal of a professional engineer registered in the State the project is located.



3.02 PULL AND JUNCTION BOXES

A. Pull and junction boxes installed within the cavity of a suspended ceiling that is not a fire rated assembly may be attached to the suspended ceiling framing members, provided the following criteria are met:
   1. Installation complies with the ceiling system manufacturer's instructions.
   2. Pull or junction box is not larger than 100 cubic inches.
   3. Support to the main runner with two fastening devices designed for framing member application and positively attach or lock to the member.
   4. Serves branch circuits and associated equipment in the area.
   5. Pull or junction box is within 6-feet of the luminaires supplied.
   6. Framing members are not rotated more than 2 degrees after installation.
   7. Install within the cavity of a suspended ceiling may be attached to independent support wires, provided the following criteria are met:
      a. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
      b. Not larger than 100 cubic inches.
      c. Secure to the independent support wires by two fastening devices designed for the application.
      d. Independent support wires in a fire-rated ceiling are distinguishable by color, tagging, or other effective means.

3.03 CABLES AND RACEWAY

A. Cables and raceway installed within the cavity of a suspended ceiling may be attached to independent support wires provided the following criteria are met:
   1. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
   2. Raceways no larger than 1-inch trade size and cables and bundled cables are not larger than 1-inch diameter including insulation.
   3. Not more than three raceways or cables supported by independent support wire and supported within the top or bottom 12-inches.
   4. Cables for telecommunications, data processing, Class 2 power-limited signaling systems, fiber optics, and other power limited systems are securely fastened within 2 feet of each termination and at intervals not to exceed 5-feet or per the manufacturer's installation instructions.
   5. Secure raceways at intervals required for the type of raceway installed.
   6. Secure cables and raceway to independent support wires by fastening devices and clips designed for the purpose.
   7. Independent support wires are distinguishable by color, tagging, or other effective means.

B. Cables and raceway installed within the cavity of a suspended ceiling may be supported with trapezes constructed of steel rods and channels provided the following criteria are met:
   1. The size of the rods, channel, and fastening devices are suitable for the anticipated weight.
   2. The spacing of the trapezes meets that required for the type of raceway installed.
   3. Secure to a trapeze by straps designed for the purpose.
   4. Cables and raceway do not support other raceway or cables.
   5. An appropriately sized seismic bracing system is installed.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Metallic Conduits
   2. Non-Metallic Conduits
   3. Wireways
   4. Fittings
   5. Metallic Boxes
   6. Floor Boxes
   7. Non-Metallic Boxes

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 29, Hangers and Supports for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

PART 2 PRODUCTS

2.01 GENERAL

A. Raceways and conduits of specified types for electrical system wiring, except where clearly indicated otherwise.

B. Fittings, boxes, hangers, and appurtenances required for the conduits and raceways.

C. Size raceways and conduits as indicated. Where no size indicated, conduit may be the minimum code permitted size for the quantity of conductors installed, based upon NEC tables for conductors with type THW insulation.

2.02 METALLIC CONDUITS

A. Rigid Metal Conduit (RMC):
   1. Smooth surfaced, heavy wall mild steel tube of uniform thickness and temper, reamed and threaded at each end and protected inside and out with galvanizing, sherardizing, or equivalent process.
   2. Comply with NEC Article 344.

B. Intermediate Metallic Conduit (IMC):
   1. Smooth surface, intermediate wall mild steel tube of uniform thickness and temper, reamed and threaded at each end, and protected inside and out with galvanizing, sherardizing, or equivalent process.
   2. Comply with NEC Article 342.

C. Electrical Metallic Tubing (EMT):
   1. Smooth surface, thin wall mild steel tube of uniform thickness and temper, galvanized or sherardized on the outside, and enameled on the interior.
   2. Comply with NEC Article 358.

D. Flexible Conduits (Flex):
   1. Flexible Metallic Conduit:
      a. Interlocking single strip steel construction, galvanized inside and out after fabrication.
      b. Comply with NEC Article 348.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

2. Liquid Tight:
   a. Similar to flexible metallic conduit, except encased in a liquid tight polyvinylchloride or equivalent outer jacket over the flexible steel core.
   b. Comply with NEC Article 350.

2.03 WIREWAYS

A. Troughs: Steel, painted, square in cross section, preformed knockouts on standard spacing, screw cover.

B. Fittings: Tees, elbows, couplings as required for configuration shown on the Drawings.

2.04 FITTINGS

A. RMC and IMC:
   1. Threaded Locknuts: Sealing type where used with NEMA 2, 3, 3R, 4, and 12 enclosures.
   2. Threaded Bushings: 1-1/4-inch and larger, insulated, grounding type as required under Section 26 05 26, Grounding and Bonding for Electrical Systems.
   3. Threaded Couplings:
      a. Standard threaded of the same material and as furnished with conduit supplied.
      b. Erickson type couplings may be used where required to complete conduit runs larger than 1-inch.

B. EMT:
   1. Connectors:
      a. Steel compression ring or steel set screw type for conduit termination, with insulated throat, suitable for conditions used.
      b. Use lay-in grounding type bushings where terminating grounding conductors.
   2. Couplings: Steel compression ring or steel set screw type, concrete tight.

C. Threadless: RMC and IMC couplings and box connectors may be steel threadless, compression ring or set screw type for use with conduits 1-inch and smaller where installed in poured concrete locations or where limited working space makes threaded fittings impractical.

D. Weatherproof Connectors: Threaded

E. Expansion Couplings: Equivalent to O.Z. type EX with jumper.

F. Seal-Offs: With filler fiber, compound, and removable cover.

2.05 METALLIC BOXES

A. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears for device ring mounting, knock-out plugs, mounting holes, fixture studs if required, RACO or equivalent.

B. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings; cast steel or aluminum with threaded hubs or bosses for use on walls.

C. Large Boxes:
   1. Boxes exceeding 4-11/16-inches when required welded steel construction with screw cover and painted, steel gauge as required by physical size.
   2. Manufacturers:
      a. Hoffman
      b. Circle AW
      c. Or equivalent.

D. Systems:
   1. Boxes for systems devices as recommended by the systems manufacturer, suitable for the equipment installed.
   2. Equip with grounding lugs, brackets, device rings, etc., as required.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 3 EXECUTION

3.01 INSTALLATION

A. Conceal conduits in finished spaces. Concealed conduits run in a direct line with long sweep bends and offsets. Where RMC and IMC embedded is in concrete below grade or in damp locations make watertight by painting the entire male thread with Rustoleum metal primer or equivalent before assembly.

B. Route exposed conduit parallel or at right angles to structural building lines and neatly offset into boxes. Conduits attached directly to building surfaces closely follow the surfaces. Conduit fittings used to saddle under beams. Coordinate drilling or notching of existing beams, trusses on structural members with Architect prior to commencing.

C. Rigidly secure RMC and IMC terminations at boxes, cabinets, and general wiring enclosures with double locknuts and bushings or approved fittings. Screw in conduit and engage at least five threads in hub where conduit boxes with threaded hubs or bosses are used. Use insulating bushings for conduits 1-1/4-inches or larger.

D. Keep conduit and raceways closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete, or foreign objects. Clean and dry raceways before installation of wire and at the time of acceptance.

E. Pack spaces around conduits with polyethylene backing rods and seal with polyurethane caulking to prevent entrance of moisture where conduits are installed in sleeves or block-outs penetrating moisture barriers.

3.02 CONDUIT

A. RMC:
   1. Use in areas for wiring systems.
   2. Install where subject to mechanical injury.
   3. Install with threaded fittings made up tight.

B. IMC:
   1. Use for circuits rated 600V and less where not in contact with earth or fill.
   2. Install with threaded fittings made up tight.

C. EMT:
   1. Securely support and fasten whether exposed or concealed at intervals of nominally every 8-feet and within 24-inches of each outlet, ell, fitting, panel, etc.
   2. Use in other dry protected locations for circuits rated 600V and less.
      a. Exceptions:
         1) Acceptable for outdoor use in photovoltaic roof applications, and within PV racking areas where not subject to damage.
         2) Acceptable for use in covered parking garages and other covered, protected areas, where periodically indirectly exposed to exterior weather conditions.
         3) Use raintight compression fittings where exposed to outdoor conditions.
   3. Do not install in areas where exposed to damage, such as vehicular or pedestrian.

D. Flex:
   1. Use for connections to vibration producing equipment and where installation flexibility is required with a minimum 12-inches slack connection.
   2. Limit flex length to 36-inches for exposed equipment connections and 72-inches in concealed ceiling and wall cavities.
   3. Use PVC jacketed flex in wet locations, areas subject to washdown, and exterior locations.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3.03 RACEWAYS

A. Surface metal wireways may be installed at locations to serve motor starters or other control devices where required by a multitude of wiring interconnections or physical layout.

3.04 FITTINGS

A. Assemble continuous and secured metallic raceways and conduits to boxes, panels, etc., with appropriate fittings to maintain electrical continuity. Cut square and reamed smooth conduit joints with fittings drawn up tight.

B. Do not use Crimp-on, tap-on, indenter type, malleable iron, or cast set screw fittings.

3.05 BOXES

A. General:
   1. Outlet Boxes: Code required size to accommodate wires, fittings, and devices.
   2. Provide multi-gang boxes as required to accept devices installed with no more than one device per gang.
   3. Equip metallic boxes with grounding provisions.

B. Size and Type:
   1. Flush wall switch and receptacle outlets used with conduit systems 4-inches square, 1-1/2-inches or deeper, with one or two-gang plaster ring, mounted vertically. Where three or more devices are at one location, use one piece multiple gang tile box or gang box with suitable device ring.
   2. Wall bracket and ceiling surface mounted luminaire outlets 4-inch octagon 1-1/2-inches deep with 3/8-inch fixture stud where required. Wall bracket outlets have single gang opening where required to accommodate luminaire canopy. Provide larger boxes or extension rings where quantity of wires installed requires more cubic capacity.
   3. Junction boxes installed in accessible ceiling or wall cavities or exposed in utility areas minimum of 4-inches square, 1-1/2 inches deep with appropriately marked blank cover.
   4. Boxes for the special systems suitable for the equipment installed. Coordinate size and type with the system supplier.

C. Pull Boxes:
   1. Provide pull boxes where shown for installation of cable supports or where required to limit the number of bends in conduits to not more than three 90-degree bends.
   2. Use galvanized boxes of code-required size with removable covers installed so that covers will be accessible after work is completed.

D. Installation:
   1. Mount boxes and outlets at nominal centerline heights shown on the drawings.
   2. Adjust heights in concrete masonry unit (CMU) walls to prevent devices or finish plates from spanning masonry joints.
   3. Recessed Boxes:
      a. Flush with finished surfaces or not more than 1/8-inch back, level and plumb.
      b. Long screws with spacers or shims for mounting devices will not be acceptable.
      c. No combustible material exposed to wiring at outlets.
   4. Covers for flush mounted boxes in finished spaces extend a minimum of 1/4-inch beyond the box edge to provide a finished appearance. Finish edge of cover to match cover face.
   5. Boxes installed attached to a stud in sheet rock walls equipped with opposite side box supports equivalent to Caddy 760. Install drywall screw prior to finish taping. Methods used to attach boxes to studs not to cause projections on the face of the stud to prevent full-length contact of sheet rock to the stud face.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

3.06 PULL WIRES

A. Install nylon pull lines in empty conduits larger than 1-inch where routing includes 25-feet or more in length or includes 180 degrees or more in bends.

B. Where conduits requiring pull lines are stubbed out and capped, coil a minimum of 36-inches of pull line and tape at termination of conduit for easy future access. Label pull lines as to conduit starting or terminations point and intended future use.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Seismic Bracing
   2. Channel Type Elements
   3. Bolting Accessories

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 29, Hangers and Supports for Electrical Systems

1.03 REFERENCED STANDARDS

A. The following are the referenced standards:

1.	SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
2.	AISC	American Institute of Steel Construction
3.	ASTM	American Society for Testing and Materials
4.	AWS	American Welding Society
5.	IBC	International Building Code
6.	ICC	International Code Council
7.	OSHPD	Office of Statewide Health Planning and Development
8.	ASCE 7-16	Minimum Design Loads and Associated Criteria for Buildings and Other Structures

1.04 QUALITY ASSURANCE

A. General Requirements:
   1. Provide seismic restraints for equipment, both supported and suspended, conduits, and cable tray systems.
   2. Bracing of conduits and cable trays in accordance with the provisions set forth in the SMACNA seismic restraint manual and the requirements set in ASCE 7 Section 13.2.
   3. Review and approve structural requirements for restraints, including their attachment to the building structure by a registered structural engineer in the same state as the project.
   4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Bracing of Conduits:
   1. Provide seismic bracing of conduit as detailed below:
      a. Brace electrical conduits 2-1/2 inch nominal diameter or larger.
      b. Brace conduits located in electrical rooms, boiler rooms, mechanical equipment rooms, and refrigeration mechanical rooms that are 1-1/4-inch nominal diameter and larger.
      c. Exception: Conduits suspended by individual hangers 12-inches or less in length, as measured from the top of the conduit to the bottom of the support where the hanger is attached, need not be braced.

C. Suspended Equipment and Raceways:
   1. Cable Method: The seismic restraint shall consist of a combination of stranded steel aircraft cable with an added nut and neoprene and steel washer.
   2. Cable attachment details, cable size, and the neoprene and steel washers shall be sized by the manufacturer and are to be indicated in the shop drawings.
   3. Provide detailed shop drawings for approval in sufficient time to allow structural attachment work to be incorporated into the normal work sequence.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

D. Seismic restraints, including anchors to building structure, designed by a registered professional structural engineer licensed in the state of Washington. Design includes:
   1. Number, size, capacity, and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both the unit to the curb and the curb to the structure. For units weighing greater than 2500 pounds, or curbs more than 10 feet long, provide substantiating calculations the curb can accept the prescribed seismic forces.
   2. Number, size, capacity, and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations, test data, or California OSHPD approval number verifying the horizontal and vertical ratings of the seismic restraint devices.
   3. Number, size, capacity, and location of braces and anchors for suspended raceways, bus ducts, and cable trays on as-built plan drawings.
      a. Select a single seismic restraint system pre-designed to meet the requirements of the latest edition of the IBC such as the 1999 Mason Industries Seismic Restraint Guidelines for Suspended Piping, Ductwork, and Electrical Systems.
      b. Details or designs from separate seismic restraint guidelines are not acceptable. Installation not addressed by the selected system shall be designed, detailed, and submitted alone with the as-built plan drawings.
      c. Maximum seismic loads shall be indicated on drawings at each brace location. Drawings shall bear the stamp and signature of the registered professional structural engineer licensed in the state of Washington who designed the layout of the braces.

E. Supports, Hangers, and Anchors: Comply with the requirements of Section 26 05 29, Hangers and Supports for Electrical Systems meet the requirements of ASCE 7 Section 13.2 based on the Seismic Design Criteria located on the structural drawings.

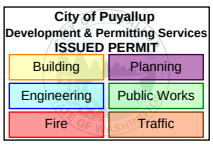
1.05 SUBMITTALS

A. Product Data: Submit product data for products specified herein.

B. Shop Drawings:
   1. Submit shop drawings complying with the requirements of the Quality Assurance article of this Section.
   2. Stamp shop drawings by a professional structural engineer licensed in the state of Washington .
   3. Approve submittals prior to rack fabrication and installation.

C. Calculations:
   1. Submit seismic calculations indicating restraint loadings resulting from the design seismic forces presented in the Quality Assurance article of this Section.
   2. Include anchorage details that include the diameter, embedment, and material grade of the material in which the anchor is placed.
   3. Stamped by a professional structural engineer licensed in the state of Washington .

D. Certifications:
   1. Submit certification of seismic restraint's and building structural member's capability to safely accept loads resulting from seismic forces calculated in the previous paragraph.
   2. Tests in three planes clearly showing ultimate strength and appropriate safety factors performed by independent laboratories and certified by a professional structural engineer licensed in the state of Washington or calculations by a professional structural engineer licensed in the state of Washington are acceptable.



PART 2 PRODUCTS

2.01 SEISMIC BRACING:

A. Steel fabrication, in accordance with AISC Steel Manual, with structural steel shapes of ASTM A 36 steel.

B. Welding in accordance with AWS D1.1.

C. Design and sizes as required.

D. Fastenings, bracing, and assembly selected by a professional structural engineer licensed in the state of Washington.

E. Show that the maximum stress in any structural steel member will not exceed 18,000 psi.

2.02 CHANNEL TYPE ELEMENTS

A. 12 gauge formed steel, 1-5/8-inch square prime painted or chromate dip finish. Use spring-in nuts with grooves.

2.03 BOLTING ACCESSORIES

A. Machine bolts with semi-finished nuts.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide support assemblies to meet the seismic zone indicated. Equipment shall be braced and anchored to conform to the requirements listed under the Quality Assurance article of this Section.

B. Seismically brace raceways, cable trays, and suspended bus duct to conform to the requirements listed under the Quality Assurance article of this Section.

C. Provide pipeline seismic flexible connectors where piping crosses building earthquake joints. Arrange raceways and connectors for the amount of motion required. Maintain continuity of the grounding system for each of the joints.

D. Do not use powder-actuated inserts.

E. Seismic Restraints:
   1. Attach to structural members of the building, which are capable of withstanding the design load of the seismic restraint.
   2. Ensure load capacity of the structural members is greater than or equal to the capacity of the seismic restraint.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Labels

1.02 RELATED SECTIONS

A. Division 01, General Requirements
B. Division 26, Electrical
C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables
D. Section 26 05 33, Raceways and Boxes for Electrical Systems
E. Section 26 24 16, Panelboards
F. Section 26 27 26, Wiring Devices
G. Section 26 29 00, Motor Controllers

PART 2 PRODUCTS

2.01 LABELS

A. Pre-printed:
   1. Permanent material pre-printed with black on white, with adhesive backing.
   2. Manufacturer:
      a. Brady
      b. 3M
      c. Or equal.

B. Engraved Laminated Plastic:
   1. 3-ply laminated plastic, colors indicated herein, with beveled edges, engraved letters, and stainless steel screw attachment.
   2. Nameplate length to suit engraving.
   3. Adhesive attachment is not acceptable.

C. Clear Plastic Tape:
   1. Black (normal) or red (emergency or standby) 12 point Helvetica medium text, clear adhesive backing, field printed with proper equipment for device labeling.
   2. Manufacturers:
      a. Brother P-Touch
      b. Dyno-tape
      c. Kroy
      d. Or equal.

D. Wire Markers:
   1. White with black numbers, adhesive-backed tape on dispenser roll.
   2. Manufacturers:
      a. Brady
      b. 3M
      c. Or equal.

E. Feeder Conduit Marking:
   1. Provide one-piece snap-around vinyl feeder conduit markers for feeder conduits.
   2. Provide custom label, black letters on orange background indicating destination equipment, 1-1/4-inch high letters (minimum) – Seton Setmark Pipe Marker Series.
   3. Provide additional one-piece snap-around vinyl label, black letters on orange background for voltage designation (i.e., 277/480V, 120/208V).
   4. Secure labels to conduits using plastic tie wrap, two per label.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

F. Marker Pen: Black permanent marker suitable for writing on metallic surfaces.

PART 3 EXECUTION

3.01 GENERAL

A. Nameplate and text coloring:
   1. Normal Black nameplate with white lettering.

3.02 DISTRIBUTION PANELS

A. Provide engraved laminated plastic nameplates for main and feeder protective devices indicating the function or the load served (e.g., ELEV-5, PANEL 4HA, AHU-5, or SPARE) and the protective device trip rating (i.e., 175A). Text height: 3/8-inch.

B. Provide engraved laminated plastic nameplate for bussed spaces indicating the maximum ampere rating of future breaker, switch, or starter that may be installed (e.g., SPACE (225A)). Text height: 3/8-inch.

C. Provide engraved laminated plastic nameplate on the face of equipment enclosure as follows:
   1. Line 1: Equipment identification (e.g., MDP, SDP, or MCC 4H). Text height: 3/4-inch.
   2. Line 2: Equipment voltage, phase and wire quantity (e.g., 480Y/277V, 3-Phase, 4W). Text height: 1/2-inch.

D. Provide additional engraved laminated plastic nameplate to indicate upstream source and location of upstream source as follows:
   1. Line 1: Upstream source equipment (e.g., FED FROM MDP). Text height: 3/8-inch.
   2. Line 2: Location of upstream source (e.g., MAIN ELEC ROOM 102). Text height: 3/8-inch.
   3. Confirm final room designations with Architect and Owner prior to procurement of nameplates.

3.03 PLUG-IN CIRCUIT BREAKERS

A. Provide engraved laminated plastic nameplate on the face of plug-in circuit breaker as follows:
   1. Line 1:
      a. Equipment served identification (e.g., T-N2P).
      b. Text height: 3/4-inch.
   2. Line 2:
      a. Circuit breaker trip rating, voltage, phase, and wire quantity (e.g., 175A, 480V, 3PH, 3W).
      b. Text height: 1/2-inch.

3.04 EQUIPMENT

A. Provide engraved laminated plastic nameplate on the face of disconnect switches, motor starters, relays, contactors, and etc., indicating equipment served (e.g., AHU-1) and equipment load (e.g., 20 hp). Provide additional engraved laminated plastic nameplate indicating serving panel designation and circuit number.

B. Provide clear plastic tape label for relays, contactors, time switches, and miscellaneous equipment provided under this Division of work indicating equipment served.

3.05 DEVICES

A. Label each receptacle plate with preprinted clear plastic tape indicating serving panel and circuit number (e.g., PANEL 2PA-5). Clean oils, dirt, and foreign materials from plate prior to label application. Label receptacles connected to a GFCI protected circuit downstream from the protecting device.

3.06 RACEWAYS AND BOXES

A. Label pull boxes and junction boxes for systems with paint or marker pen on box cover identifying system. Where box covers are exposed in finished areas, label inside of cover.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

B. Color label covers as follows:

1.	480Y/277V wiring	Orange
2.	208Y/120V wiring	Black

C. Label each end of pull wires left in empty conduits with tags or tape indicating location of other end of wire.

3.07 EXISTING EQUIPMENT

A. Provide new nameplates and labels for existing distribution equipment in accordance with panel descriptions shown on the Drawings. Provide new labels for feeder devices where labels are non-existent, incorrect, or confusing on existing distribution panels affected by this work.

B. Equip existing branch circuit panelboards scheduled to remain with new, accurate, typed, circuit directories where circuiting changes are made.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Testing Equipment

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 24 16, Panelboards

F. Section 26 29 00, Motor Controllers

1.03 TESTING CRITERIA

A. General:
   1. Perform field tests and operational checks to assure that all electrical equipment, both contractor and Owner supplied, is operational within industry and manufacturer's tolerances, and is installed in accordance with design specifications.
   2. The tests and operational check shall determine the suitability for energization.
   3. Schedule tests and give a minimum of one week's advance notice of time and date to the Architect and Owner for any major systems tests specified in this Section.
   4. The testing company shall provide the equipment and technical personnel to perform all tests and inspections. At Contractors expense, furnish any personnel necessary to assist in the testing and inspection.
   5. When tests and inspections are complete, attach a label to the devices tested. Provide on the label, the name of the testing company, date of tests, and initials of the Engineer who performed the tests.

B. Responsibilities:
   1. Clean the equipment, torque down accessible bolts according to the equipment manufacturer's instructions; perform routine insulation resistance tests on branch and feeder circuits, continuity checks on branch and control wiring, and rotation tests for distribution and utilization equipment.
   2. Furnish a complete set of current plans and specifications to the testing company prior to commencement of testing. At each test site, provide test control power necessary to perform the tests specified. Consult the test organization as to the specific power requirements. Notify the testing organization when the equipment and systems are ready for their inspections and testing. After review by the testing engineer, correct deficiencies noted by the testing company.
   3. Responsible for having the manufacturer of each equipment and/or system provide factory trained representatives(s) that will perform required functional testing, checkout, and repairs in order to pronounce the equipment and/or systems meet the requirements of these specifications and drawings and it is ready for startup testing and commissioning by the testing organization as specified hereafter.
   4. Furnish settings of protective devices by the Engineer, in conjunction with Utility.
   5. Testing organization to notify Engineer prior to the commencement of testing. The testing organization, set, and adjust the protective devices and associated auxiliary timing devices in accordance with the values furnished by the Engineer. The testing organization maintains a written record of tests and, upon completion of the test, include them in a final report. Detail deficiencies in the system material, workmanship, or design.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

C. Implementation:
   1. Safety practices comply with applicable state and local safety orders, as well as with the Occupational Safety and Health Act (OSHA). Compliance with the National Fire Protection Association (NFPA) standard NFPA 70E, and the Accident Prevention Manual for Industrial Operations of the National Safety Council.
   2. Tests, other than phase rotation and operational tests, only performed on apparatus that is deenergized. The testing company's lead test engineer for the project designated safety representative and supervise testing observations and safety requirements. Do not proceed with Word until determined that it is safe to do so.
   3. Power Circuits: Conductors shorted to ground by a hotline grounding device approved for the purpose. Provide warning signs and protective barriers as necessary to conduct the tests safely.

D. Reports:
   1. General: Provide full documentation of tests in the form of a report.
   2. Test report includes the following sections:
      a. Scope of Testing
      b. Equipment Tested
      c. Description of Test
      d. Test Results
      e. Conclusions and Recommendations
      f. Appendix, including Test Forms
   3. Record each piece of equipment on a data sheet listing the condition of the equipment as found and as left. Include recommendations for necessary repair and/or replacement parts. Indicate on data sheets the name of the engineer who tested the equipment and the date of the test completion.
   4. Submit record copies of the completed test report no more than 30 days after completion of the testing and inspection.

1.04 REFERENCES

A. The testing and inspection comply with applicable sections of the applicable codes and standards listed in Section 26 05 00, Common Work Results of Electrical of the project specifications.

B. The inspection and testing comply with the project plans and specifications, as well as with the manufacturer's drawings, instruction manuals, and other applicable data that may be provided by the Engineer, for the apparatus tested.

1.05 QUALIFICATIONS

A. Testing Organization:
   1. Independent division of the manufacturer of the assembled products being tested. If an outside testing organization is utilized, a representative of the manufacturer under contract by the testing company. Be present during testing to ensure the testing is performed properly and deficiencies discovered are promptly corrected.
   2. Full Service Company that employs factory trained test engineers capable of troubleshooting, as well as identifying power equipment problems.
   3. Perform Work outlined under the full time, onsite supervision of a graduate engineer with a minimum of 5 years of field testing experience.
   4. Upon request, submit proof of its qualifications.

PART 2 PRODUCTS

2.01 TESTING EQUIPMENT

A. Testing agency to have calibration program, which maintains applicable test instrumentation within rated accuracy. Traceable accuracy to the National Bureau of Standards in an unbroken chain. Calibrate instruments calibrated in accordance with the following frequency schedule:
   1. Field Instruments: 6 months maximum.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

2. Laboratory Instruments: 12 months.
3. Leased Specialty Equipment: 12 months (where accuracy is guaranteed by lessor). Dated calibration labels visible on test equipment.

PART 3 EXECUTION

3.01 EQUIPMENT TO BE TESTED

A. Section 26 29 00, Motor Controllers

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Branch Panelboards
   2. Identification

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

G. Section 26 05 80, Electrical Testing

1.03 SUBMITTALS

A. Shop Drawings

B. Product Data
   1. Detailed component material list.
   2. Voltage rating, amperage rating, bussing material, fault rating, wiring lugs capacity, mounting method, physical size, exterior finish and options.
   3. Individual circuit breaker product data sheets.
   4. Panel schedules indicate circuit breakers in the same orientation as the construction documents.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Panelboards use the same manufacturer as existing infrastructure..

2.02 BRANCH PANELBOARDS

A. Branch Circuit Panels:
   1. Bolt-on circuit breaker type fitted with metallic flush lift latches and locks keyed alike.
   2. Deliver panel keys to the Owner at completion of the project.

B. Short Circuit Current Rating (SCCR):
   1. Fully rated at a value greater than the maximum available short circuit current that can be expected at the panelboard location in the electrical system.
   2. Series rating is not permitted.

C. Wiring Gutters:
   1. Minimum of 4-inches wide except where feeder conductors enter where a minimum of 6-inches clear.
   2. Feeder conductors to enter directly in line with lug terminals wherever practicable.
   3. Provide separate feeder studs for each feeder conductor compression lug.

D. Bussing:
   1. Provide one continuous bus bar per phase.
   2. Provide copper or electrical grade aluminum alloy sized as indicated on the drawings and in accordance with UL standards to limit temperature rise on current carrying part to a maximum of 149 degrees F above an ambient temperature of 104 degrees F maximum.
   3. Full size insulated neutral bars included for panels indicated to have a neutral.
   4. Bus bar taps for panels with single pole branches arranged for sequence phasing of the branch circuit devices.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

E. Ground Bus: Provide in each panelboard and include the following:
   1. Have the same rating as the neutral bus.
   2. Contain a ground conductor terminal for each available circuit in the panelboard.
   3. Size terminals for branch circuit equipment grounding conductors.

F. Isolated Ground Bus: Provide in each panelboard as indicated and included the following:
   1. Insulate from the panelboard enclosure.
   2. Same rating as the neutral bus.
   3. Contain a ground conductor terminal for each available circuit in the panelboard.
   4. Have terminals sized for the branch circuit equipment grounding conductors.

G. Interiors:
   1. Main lug only unless otherwise indicated, with dead front shield covering the bus, and bus connectors, with mounting hardware and bussing for spaces indicated for future installation of devices.
   2. Dead front construction for interior trim.
   3. Cover unused mounting spaces with preformed knockouts.

H. Branch Circuit Breakers:
   1. Provide with amperage rating, and number of poles as indicated in the Panelboard Schedules.
   2. Bolt-on type circuit breakers.
   3. Over center toggle mechanism that provide quick-make, quick-break contact action. Circuit breakers have thermal and magnetic trip elements in each pole. Two and three pole circuit breakers have an internal common trip crossbar to provide simultaneous tripping.
   4. Exposed faceplates of circuit breakers flush with one another.
   5. Short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for circuit breakers: 10,000 AIC for 120V and 208V breakers, 14,000 AIC for 277V and 480V breakers.
   6. Circuit breakers used for switching duty UL listed for that purpose and marked SWD.
   7. Provide each branch circuit breaker with a factory padlock-able lock-off provisions.

2.03 IDENTIFICATION

A. Identify branch circuit breakers with individual circuit numbers adjacent to each breaker with a typewritten card to identify the load controlled by that breaker.

B. Provided with complete schedules of panelboards as designed prior to start of construction. Schedules will include circuit breaker arrangement, load schedules, and ratings for use in identification of circuits and coordination.

C. Refer to Section 26 05 53, Identification of Electrical Systems for additional requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide identification and panel schedules as specified in Section 26 05 53, Identification of Electrical Systems.

3.02 SALVAGE

A. Utilize circuit breakers in existing panels that are to remain. Where faulty or inadequate breakers are found in these panels, replace with suitable breakers from panels removed during demolition.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Receptacles
   2. Plates

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

G. Section 26 05 80, Electrical Testing

1.03 SUBMITTALS

A. Product Data

B. Completed Receptacle Testing and Acceptance Report Form.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Receptacles:
   1. Use same manufacture as the Line Voltage Wall Switches.
   2. Hubbell
   3. Leviton
   4. Arrow-Hart
   5. Pass & Seymour

B. Plates:
   1. Hubbell
   2. Leviton
   3. Arrow-Hart
   4. Pass & Seymour

2.02 MATERIALS

A. Extra heavy duty grade wiring devices, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed. Device of same grade and manufacture as specified below. Furnish a matching plug connector for special purpose devices that do not have the common 120V NEMA 5-20R configuration.

B. Duplex receptacles installed have similar appearance characteristics unless noted otherwise.

2.03 RECEPTACLES

A. Standard Straight Blade Duplex Receptacle:
   1. 3-wire, 2-pole with grounding, extra heavy duty, 20A rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.
      a. Provide hospital grade in patient care areas as required by NEC.
      b. Provide tamper-resistant as noted on the drawings or NEC required.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

2. Ground Fault Interrupting straight blade duplex receptacle:
   a. Heavy duty, 3-wire, 2 pole with grounding, self-testing, green “ON” LED to indicate power, red “ON” LED to indicate ground fault condition, 20A rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.
      1) Provide hospital grade in patient care areas as required by NEC.
      2) Provide tamper-resistant as noted on the drawings or where NEC required.
      3) Provide weather-resistant rating at exterior locations as required by NEC.

B. Exposed Device Color, unless otherwise noted, is as follows:
   1. Normal power: Gray or as selected by Architect.

2.04 PLATES

A. Flush Finish Plates:
   1. Coordinated with Architect.

B. Surface Covers:
   1. Galvanized or cadmium plated steel, 1/2-inch raised industrial type with openings appropriate for device installed.

C. Weatherproof:
   1. Extra-Duty while in use covers, UL 514D listed, commercial quality die cast aluminum construction, NEMA 3R rated, gasketed, built-in padlock provisions, built-in cord strain relief provisions, gray powder-coated finish, vertical mounting as required for application or other covers of similar construction for other receptacle configurations.

D. Identification:
   1. Identify receptacle plates with a pre-printed label indicating serving panel and branch circuit number.
   2. Refer to Section 26 05 53, Identification for Electrical Systems.

PART 3 EXECUTION

3.01 INSTALLATION

A. Devices and finish plates installed plumb with building lines. Install wall mounted receptacles vertically at centerline height shown on the Drawings.

B. Finish plates and devices are not installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.

C. Receptacles and/or other devices ganged into a common enclosure provided with a separation barrier between devices where the combined circuit voltages within the enclosure exceeds 300V.

D. Provide GFCI receptacles as shown on the drawings or as NEC required. Provide a GFCI type duplex receptacle in each required location, do not sub-feed normal receptacles downstream of the GFCI receptacle to obtain the GFCI rating.

E. Provide receptacles with GFCI, tamperproof, weather-resistant or hospital grade ratings as shown on the drawings, appropriate for the installation or required by NEC.

3.02 COORDINATION

A. Electrical Drawings indicate the approximate location of devices. Refer to Architectural elevations, sections, and details for exact locations.

B. Coordinate with equipment installer the locations and methods of connection to devices mounted in cabinets, counters, work benches, service pedestals, and similar equipment.

3.03 TESTING

A. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct defective wiring.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

B. Provide testing of patient care receptacles per NFPA 99 6.3.3. Record test results on the Receptacle Testing and Acceptance Form and submit to the engineer of record for review and inclusion to the Washington State Health Department.

C. Test receptacles per the criteria/requirements of NFPA 99, Chapter 6, 3.3.

D. Receptacle testing report form example is as follows:

Receptacle Testing and Acceptance Report Form						Date	
Room/Area	Receptacle Test			Ground System Voltage/Impedance		Grounding	Exceptions/Remarks
	Physical Integrity	Polarity	Tension >4oz	New <20m V	Impedance <0.1 Ohms		

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Motor Starters
   2. Disconnects
   3. Fuses

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cable

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 53, Identification for Electrical Systems

F. Section 26 05 80, Electrical Testing

1.03 SUBMITTALS

A. Shop drawings, including the following information.
   1. Field Dimensions
   2. Description of Materials and Finishes
   3. Component Connections
   4. Anchorage Methods.
   5. Installation Procedures

B. Product Data

C. Operating and Maintenance Data

D. Overload (Heater) Sizing: A final listing of motors and the heater size installed for that motor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Motor Starters and Visible Blade Disconnects:
   1. Same manufacture as the distribution equipment specified in Section 26 24 13, Switchboards.
   2. Allen Bradley
   3. Or approved equivalent.

B. Horsepower Rated Toggle Switches:
   1. Arrow Hart
   2. General Electric
   3. Hubbell
   4. Pass & Seymour

2.02 GENERAL

A. Provide manual or magnetic motor starters of the proper characteristics for equipment as indicated.

B. Provide switches of proper characteristics as disconnecting means.

2.03 MOTOR STARTERS

A. Manual Starters:
   1. NEMA ICS 2, AC general purpose Class A manually operated toggle type full voltage controller for fractional horsepower induction motors, quick-make, quick-break, with thermal overload protection and suitable enclosures.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building | Planning
Engineering | Public Works
Fire | Traffic

B. Magnetic Starters, Non-reversing:
   1. NEMA ICS 2, AC general purpose, full voltage across the line non-reversing type, 120V coils, overload relays in each leg, running pilot lights, one normally closed and one normally open auxiliary contacts, 120V control transformers and suitable enclosures.
   2. Overload relays ambient compensated bimetallic type with interchangeable heater pacts.
   3. Overload adjustable, have single-phase sensitivity, and manual or automatic reset.
   4. Suitable for the addition of at least four auxiliary contacts of arrangement normally open or normally closed.
   5. Provide with a NO and a NC auxiliary contacts.
   6. Minimum fault interrupting rating of 10,000A.

C. Magnetic Starters, Reversing:
   1. NEMA ICS 2, AC general purpose.
   2. Reversing starters consist of two contactors and a single overload relays assembly.
   3. Include electrical interlock and integral adjustable time delay transition between FORWARD and REVERSE rotation.
   4. Starters electrically and mechanically interlocked to prohibit line shorts and both starters being energized simultaneously.

D. Magnetic Starters, Two Speed:
   1. NEMA ICS 2, AC general purpose.
   2. Include electrical interlock and integral adjustable time delay transition between SLOW and FAST speeds.
   3. Electrically and mechanically interlocked to prohibit both starters being energized simultaneously.

E. Combination Starter/Disconnect, (Circuit Breaker):
   1. Combine magnetic motor starter as described above and motor circuit protector disconnect in a common enclosure.

F. Motor Circuit Protector:
   1. NEMA AB 1, circuit breaker with integral instantaneous magnetic trip in each pole.
   2. Externally operated handle, giving positive visual indication of its ON-OFF position.

G. Thermal Magnetic Circuit Breaker:
   1. NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole.
   2. Circuit protector externally operated handle, giving positive visual indication of its ON-OFF position.

H. Combination Starter/Disconnect, Disconnect Switch Type:
   1. Combine magnetic motor starter as described above and non-fused or fused disconnect switch in a common enclosure. Switch type as indicated on the drawings. Switch has an externally operated handle that gives positive visual indication of its ON-OFF position.
   2. Non-fused Switch Assemblies:
      a. NEMA KS 1, enclosed knife switch with enclosed, but visible blades. Switch rated as indicated on the drawings.
   3. Fused Switch Assemblies:
      a. NEMA KS 1, enclosed knife switch. Fuse clips accept Class R fuses. Switch and fuse sizes as indicated on the drawings.

I. Starter Contacts:
   1. Totally enclosed, double break, silver-cadmium-oxide power contacts.
   2. Contact inspection or replacement possible without disturbing line or load wiring.

J. Enclosure:
   1. NSI/NEMA ICS 6, Type 1 as indicated, or as required to meet the conditions of installation.

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic

K. Equip starters with H-O-A selector switches, start-stop stations, or other auxiliary control device listed. Where no auxiliary devices are listed, equip each starter with an H-O-A switch.

L. Provide a control circuit transformer in each starter. Size transformer to accommodate the contactor(s) and control circuit loads. Include primary and secondary fuses in ungrounded conductors.
   1. Provide one normally open and one normally closed auxiliary contacts in each starter, unless additional auxiliary contacts are required. NEMA ICS 2.

M. Provide starter units with control terminal blocks. Terminal blocks rated at 20-Amperes and accessible from inside the unit with the unit door is opened.

N. Push Buttons: Unguarded, recessed type

O. Indicating Lights, LED type:
   1. Green for run.
   2. Red for stopped unless otherwise indicated.

2.04 DISCONNECTS

A. Safety and disconnect switches NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Equip switches with defeatable cover interlock.

B. Enclosures NEMA l for indoor use, unless specifically noted otherwise and NEMA 3R where installed exposed to the weather or designated by the subscript WP.

C. Fusible or non-fusible as designated on Drawings.

2.05 FUSES

A. UL Class RK-5 dual element, time delay, current limiting type. The overload thermal time delay element spring actuated soldered copper assembly in a separate sand free compartment. The short circuit current limiting section copper alloy links encased in quartz sand.

B. Capable of holding 500 percent of rated current for a minimum of 10 seconds, and carry a UL listed minimum interrupting rating of 200,000A rms symmetrical.

PART 3 EXECUTION

3.01 MOTOR STARTERS

A. Provide the motor starting equipment as shown on the Drawings and coordinate motor overload starter relays.

B. Install the starters at the respective equipment unless shown otherwise.

C. Install freestanding starters on metal channel support structure.

D. Starters that are installed on exterior walls installed with minimum 1/2-inch channel on wall to allow air space between starter and wall.

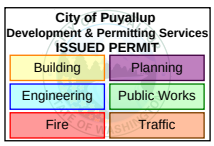
E. Where fusible units are provided, install fuses as indicated on the drawings.

F. Install thermal overloads (heaters) in each starter in accordance with the manufacturer's recommendations for that motor and the type of associated load. Coordinate proper size when individual power factor capacitors are utilized at the motor.

3.02 DISCONNECT SWITCHES

A. Provide code required disconnect switches under this work.

B. Non-fusible disconnect switches required when equipment is not in sight of the branch circuit panel or starter may be horsepower rated, toggle type in suitable enclosure, mounted at or on the equipment.



3.03 FUSES

A. Install fuses for motor protection to best protect the motor without nuisance tripping. Should fuse sizes require changing from what is shown due to variance between the original design information and actual equipment installed, fuses sized in accordance with NEC. Do not size fuses smaller than the starter heaters on motor circuits.

B. Provide one complete set of spare fuses of each amperage used on this project. Store spare fuses in the spare fuse cabinet.

3.04 COORDINATION

A. Verify the characteristics and the motor full load current for each motor installed, using the actual motor nameplate data. Select and install the proper running overload devices in the starter as per the manufacturer's instructions. Provide the proper overload protection is a part of this Division of the work.

B. Prepare table of motor full load currents and installed overload devices and submit to the Architect.

END OF SECTION

City of Puyallup
Development & Permitting Services
ISSUED PERMIT
Building Planning
Engineering Public Works
Fire Traffic