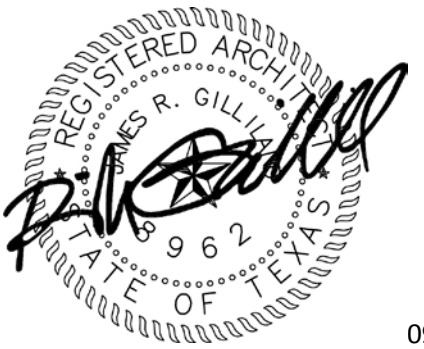

09.07.2012

Office Building Addition and Remodel

Project Manual

RGA Architects
301 S. Oak St., Suite 100
Roanoke, TX 76262

Civil Engineering: G&A Consultants, Inc.
Landscape Architecture: G&A Consultants, Inc.
Structural Engieering: McHale Engineering, Inc.
Mechanical, Electrical, Plumging Engineering: Systems Associates, Inc.

September 2012

SECTION 00300

BID FORM

DATE:

TO: Mr. Ryan Williams
Priority One
204 Front Street
Roanoke, TX 76262

cc. Mr. Rick Gilliland
RGA Architects
215-A North Oak Street
Roanoke, TX 76262

RE: Priority One Building Expansion and Remodel
204 Front Street
Roanoke, TX 76262

Gentlemen:

Pursuant to the Instruction to Bidders, the undersigned has thoroughly examined the Bidding Documents and the Site, understands the work to be done, and hereby proposes to do all the work as provided in the Bidding Documents and subject to the observation and approval of the Owner and Architect, and binds themselves on acceptance of this bid by the Owner for performing and completing the said work within the time stated and to furnish all required guarantees for the following prices:

BID:

For the construction of this project.

The Sum of _____DOLLARS

Completion Date _____

EXTRA WORK FEES:

The undersigned agrees that for additional work added to the Contract and for extra costs resulting from changes in the work, the allowance for overhead and profit combined shall be in accordance with the following schedule, as provided in the Supplementary Conditions: (Overhead shall also include payroll taxes and supervision):

A. For the Contractor, for any work provided by his own forces: ___ percent mark-up of the cost.

B. For each subcontractor, work performed by their own forces: ___ percent mark-up of the cost.

C. For the Contractor, for work produced by his subcontractors: ___ percent mark-up of the amount due the subcontractor.

ADDENDA:

This will acknowledge receipt of the following addenda which are part of the Bidding Documents:

Addendum No. _____ Addendum No. _____

Addendum No. _____ Addendum No ._____

CONTRACT TIME:

The undersigned Bidder hereby declares that he has visited the site of the Work and has carefully examined the Contract Documents pertaining to the Work covered by the above Bid, and he further agrees to commence work within 10 days after date of written notice to do so and to substantially complete the work within (_____) calendar days, subject to such extensions of time allowed by Specifications.

The undersigned Bidder agrees that his Bid shall be good and may not be withdrawn for a period of 60 calendar days after the scheduled closing time for receiving bids.

The undersigned Bidder understands that the Owner reserves the right to reject any or all Bids and to waive any informalities in the Bidding.

COST BREAKDOWN:	**Cost of Item**
General Conditions, including Permit Fee	_____
Overhead and Profit	_____
Demolition	_____
Site Clearing, Grading and Backfill	_____
Storm Drainage and Site Utilities	_____
Paving, Curbs, and Walks	_____
Miscellaneous Site Work	_____
Landscaping and Irrigation	_____
Cast-In-Place Concrete – Foundations/Piers	_____
Concrete Floor Slabs	_____

Masonry (Face Brick)	_____
Masonry (Stone)	_____
Cast Stone	_____
Stucco	_____
Structural steel	_____
Steel Joists and Steel Girders	_____
Miscellaneous Steel/Metal Fabrications	_____
Rough Carpentry/Wood Framing	_____
Membrane Roofing	_____
Standing Seam Metal Roofing	_____
Insulation	_____
Doors, Frames, and Hardware	_____
Entrances and Storefront Windows	_____
Glass and Glazing	_____
Drywall	_____
Paint	_____
Finish Carpentry and Millwork	_____
Acoustic Ceiling	_____
Floor Coverings	_____
Specialties	_____
Equipment	_____
Furnishings	_____
Elevator	_____
Trash Chute	_____
Plumbing	_____
Fire Protection	_____
HVAC	_____
Electrical	_____
Taxes	_____

Total Construction Cost _____

I have attached the required Subcontractor listing to this Proposal.

_____

Contractor (firm name)

By_____Corp. Title_____

Address_____City_____State_____

Phone_____Facsimile_____

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(Civil and Landscape Specifications are contained in separate documents)

Division 1 - General Provisions

1000 Agreement Form

1001 The form of agreement for the contract will be AIA Document A101-2007, Standard Form of Agreement Between Owner and Contractor, or a mutually acceptable alternative.

1100 Project Documentation

Project documentation shall include all items required by the Specification and Construction Contract for all phases of the development process.

1101 This specification is intended to define the general expectations related to the scope of work. Code requirements and the contract documents consisting of the approved plans and specifications shall take precedence over the information contained herein. All construction shall comply with local, state and federal codes and regulations, including all applicable accessibility standards.

1102 The drawings and these specifications are complementary to each other. Work required by one shall be considered included in the other. It is not the intention of the drawings and specifications to show all materials, equipment, etc., necessary for the proper construction of all systems involved. Systems and components indicated shall include all necessary parts, fittings, and accessories required to provide a complete and operational system, regardless of whether those items are specifically noted in the specification or on the drawings. If there is a conflict in the drawings, or between the written specs and the drawings, the contractor shall submit a request for clarification in writing to the Architect a minimum of 24 hours prior to bid deadline. If no clarification is received, the Contractor shall be responsible for the more expensive of the options.

1103 The Contractor and his trades shall coordinate all work with the following entities: all local, municipal, state and federal agencies having jurisdiction over the project; all separate Contractors and/or agents of the Owner to perform work on the project. The Contractor shall be responsible for the coordination of all work necessary for the completion of the project in accordance with the plans and specifications (excluding the connection of equipment and installation of materials supplied by others, unless clarified by bid submittals, with monetary stipulations). No changes in the contract amount will be made due to lack of coordination.

1200 Quality Control

The quality control process shall include the project developer, general contractor, design engineers, architect, materials testing contractor, material suppliers, and material manufacturers.

1201 Testing and reporting protocol is to be established, based on project specific conditions, to meet all code requirements and standard practices. The project team shall conform to testing requirements defined in Chapter 17 of the International Building Code (comply with requirements in the edition of the building code currently adopted by the authority having jurisdiction over the project).

1202 Frequency and protocol for soils testing, rebar inspections, concrete testing, NPDES inspections, steel welding and bolt torque inspections, utility inspections (TV, bacteriological), pavement inspections, roofing inspection, and all other items of work are to be reviewed by the Architect. Written reports of all inspections, as well as reports documenting the correction of any defective work, shall be forwarded to the Architect at the completion of the project.

1203 The design team shall make monthly jobsite visits and document observations in a report.

1300 General Conditions

1301 The “General Conditions of the Contract for Construction,” AIA Document A201, are part of the contract. The General Conditions and all modifications shall apply to all various subcontractors and sub-Subcontractors.

1302 This project shall be executed in two (2) phases. During the first phase, the Owner will continue to occupy and work out of the existing building, while the two (2) story addition is under construction. Upon completion of that portion of the project, the Owner will move out of the existing building and occupy the new areas, at which time, construction may commence on the remodel of the existing building.

A. Prior to beginning construction of Phase One, two (2) openings will be cut in the north tiltwall to serve as future connections between the existing and new areas. These openings will be immediately closed with temporary protective stud, plywood, and insulation infill, for the duration of Phase One.

B. The Contractor shall at all times use practices that attempt to minimize disruption of the Owner's ongoing business.

1302 Terms and conditions of the construction contract shall take precedence over provisions of standard specification.

1303 Obtaining all required permits and/or filing all required notices, and paying necessary fees for such, shall be the responsibility of the general contractor. The Owner is to be notified of any permits, easement, notices, or filings that must be the responsibility of the Owner. The contractor shall be responsible for items including, but not limited to, the following:

Building Permits
Site Development Permits
Utility Tap Permits and Fees
Environmental Permits
DOT Permits
Impact Permits
DRI Permits
NPDES (NOI / NOT)
Lien Law Filings (Notice of Commencement)
Design Control Committee Approvals
Access or Utility Related Easements

1304 Contractor shall provide full-time on-site project management/superintendent to coordinate the work of all trades, monitor safety, maintain quality, and ensure that job site is maintained in a neat and orderly fashion.

1305 Provide necessary field engineering, including field surveying, as well as site and building layout for the project.

1306 Provide all necessary temporary facilities and permanent/temporary utilities. Schedule interruptions necessary for making connections for temporary or permanent services. Temporary facilities shall include, but are not limited to:

A. Project field office with necessary furnishings for project meetings and telephone, fax, and e-mail service.
B. Drinking water and sanitary facilities for workmen.
C. Temporary roads, staging, and storage areas, including secure areas for tools, materials, and equipment.
D. Project identification and directional signs.
E. Temporary fencing or other necessary protection of the work.
F. Safety provisions.
G. Waste disposal.

1307 Provide and pay for all utilities until Substantial Completion of the work.

1308 Produce a coordinated construction progress schedule and manage the project as required for orderly progress of the work, including coordinating the sequence of activities and required tests/inspections.

1309 Schedule product deliveries to avoid conflict with work and conditions at site. Store and protect products in accordance with manufacturer's instructions. Provide off-site storage and protection when site does not permit on-site storage.

13010 Deliver products in undamaged condition, in original unopened containers, with identifying labels intact and legible. Store and protect products in accordance with manufacturer's instructions. Arrange storage to permit access for inspection.

13011 Maintain the project site in a clean and orderly condition. Contractor is responsible for cleaning on a day-to-day basis. Failure to abide by this provision may result in Owner contracting the cleaning and back-charging the cost to the General Contractor. Perform final clean of project upon completion of the work.

13012 Provide required warranties, including 1 year warranty for the project as a whole and extended warranties/maintenance or service agreements as indicated in the terms and conditions of the construction contract.

13013 Contractor shall provide builders risk insurance which shall cover the full value of the work being performed. Terms and conditions of the construction contract shall take precedence over provisions of standard specification.

13014 Provide hard copies as well as an integrated electronic copy in .pdf format of project close-out documents upon completion of the work, including Record Drawings, copies of all approved submittals, operation and maintenance manuals, copies of all warranties, and similar items as follows (and as indicated in the terms and conditions of the construction contract):

A. Project Team Directory listing firm names, addresses, telephone numbers, email addresses, and name of project manager for the project team; including the Owner, Architect, Civil Engineer, Structural Engineer, MEP Engineer, General Contractor, and all Subcontractors.
B. Permits and regulatory approvals for the project, including all building permits, site development permits, and public utility permits.
C. Plan review and inspection reports, including building permit comments and response, accessibility plan review and inspection reports, third party final inspection report, construction inspection tags (final green tags only).
D. Project documents, including Certificate of Occupancy or Compliance, Certificate of Substantial Completion, ALTA Survey, plat, title documents, easements by separate instrument, and Environmental reports (Phase 1, Conclusion).
E. Geotechnical and Materials Testing reports, including geotechnical report, geotechnical engineer's Letter of Acceptance, structural engineer's Letter of Acceptance, and fire pump flow test report.
F. Architectural and Engineering documents, Record Drawings (11x17), Fire Protection shop drawings (11x17), and project manual/specifications and written addenda.
G. Construction documentation, including executed copy of Construction Contract, final Application for Payment (with back-up), Change Orders, Affidavit of Final Acceptance, Final Release of Liens, Final Insurance Certificate, signed-off version of punch list, business licenses, and report of verification of clear height and encumbrances.
H. Warranties, including General Contractor warranty, manufacturer's roof warranty, other manufacturers' warranties, subcontractors' warranties.
I. Operations and Maintenance Manual, organized in CSI, 16 division format.

13015 To minimize disruption of Owner's activities after occupancy of premises, coordinate access to site by various trades for correction of defective work and for correction of work not in accordance with Contract Documents.

1400 Existing Structure

1401 Nothing may be mounted on the roof or suspended from the roof structure without approval of the structural engineer.

1402 Under no circumstances shall the building be left unsecured due to cutting and patching operations.

End of Division

Division 2 - Sitework

2000 Earthwork

2001 Unless specifically otherwise approved by the Architect, earthwork shall be designed to "balance" the cut and fill on the site. Haul-in and haul-off of material, including unsuitable soil and top soil, should be minimized. Design shall use a reasonable shrinkage factor for cut and fill based on anticipated volume changes due to compaction, etc. A current survey, topographical survey, detailed geotechnical investigation, environmental survey, and any other baseline information are required to be considered during the design process. The geotechnical engineer shall review the final plans and specifications.

2002 Detailed NPDES compliant design documents, including but not limited to Erosion Control Plan (prepared by licensed civil engineer), Storm Water Pollution Prevention Plan, Site Notification of SWPPP, and Notice of Intent, will be prepared to include all BMP, stabilization, and testing criteria as required by regulations and responsible design practices.

2003 Clearing and grading operations will be designed and constructed with the input of the geotechnical engineer. The work will be monitored by the geotechnical engineer to assure conformance to specifications. All work will be performed in strict accordance with OSHA and other safety regulations.

2004 Unit prices for remedial work such as unsuitable soil replacement (on-site and off-site borrow), chemical enhancements, soils mixing, and other work typically encountered in a given market are to be determined before awarding the general contract. A contingency budget for these items should be developed with the input of the engineer and contractors.

2100 Site Utilities

2101 Storm Water Systems: Provide storm water conveyance and surface drainage as shown on Civil drawings, as required by local codes.

2102 Fire Suppression Water Service
A. Fire suppression water service shall be dedicated for fire protection systems and designed to comply with good engineering practice.
B. Provide full metering and back flow protection as required by local jurisdiction.

2103 Potable (Domestic) Water Service: Potable Water Service shall be provided. All potable water service piping shall be copper. Unless specific conditions of the project require otherwise, provide new 2" diameter domestic water service to water connection at property line or in street as required. Water service implies that the cost for all equipment and fees are inclusive. Provide backflow preventer or pressure reducer as required by municipal codes.

2104 Sanitary Sewer Service: Sanitary sewer service to building shall be provided per local engineering standards.

2105 Irrigation Water Service: Irrigation water service shall be provided with a separate meter to provide for the landscaping irrigation system.

2106 Gas Service: Gas Service shall be provided. The service size and pressure shall be coordinated with the mechanical engineer and the gas service provider.

2107 Electrical Service: Electrical service shall be provided to the building. The primary service to the building shall be routed underground. Verify all utility company charges with electrical service provider. All costs for the electric service, including service provider charges, underground primary conduits, transformer pads, secondary conduits, tap/cans, and conductors shall be included in the project budget.

2108 Telephone (Data/Fiber Optic) Service: Telephone (data/fiber optic) Service shall be provided to the building. The exact service size/configuration, along with the quantity, size, and location of conduits for the service, shall be coordinated with the service provider

2200 Paving

2201 The pavement and base details shall be as shown on drawings.

2202 The perimeter of all paved areas shall have concrete curb. Curbs at all automobile parking areas shall be typical 6" tall curbs.

2203 All designated entrances to the building shall comply with TAS Design Guidelines for accessible routes (running slope and cross slope), handicapped parking, changes in level at door thresholds, and other criteria.

2204 Miscellaneous Design Criteria:
A. Provide termite treatment.

2300 Landscaping and Irrigation

2301 Provide complete irrigation system at all landscaped areas.

2302 Maintain landscaping for a minimum of 90 days following Substantial Completion of the project or until all areas are established and Notice of Termination is filed, whichever is longer.

02372 Drilled Piers

Refer to Structural Drawings for Drilled Piers Specification.

02400 Termite Control

2401 Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent. Use only soil treatment solutions that are not harmful to plants. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA-Registered Label.

2402 Engage a licensed professional pest control operator to apply termite control solution.

2403 Prepare surfaces and apply treatment using procedures, rates and concentrations recommended in manufacturer's written instructions to the following: foundations; under concrete floor slabs on grade; at hollow masonry; at expansion and control joints and slab penetrations; soil under and adjacent to foundations, including entrance platforms, porches, and equipment bases.

2404 Provide stainless steel mesh termite control barrier at slab penetrations and at the outer wall cavity, according to manufacturer's instructions.

End of Division

Division 3 – Concrete

03100 Concrete Formwork
Refer to Structural Drawings for Concrete Formwork Specification.

03200 Reinforcing Steel
Refer to Structural Drawings for Reinforcing Steel Specification.

03300 Cast-In-Place Concrete
Refer to Structural Drawings for Cast-In-Place Concrete Specification.

03345 Concrete Finishing
Refer to Structural Drawings for Concrete Finishing Specification.

3400 Slab Systems

3401 Provide slab as designed and shown on structural drawings.

3402 Prior to commencing concrete operations on the project, a preconstruction meeting **(pre-slab meeting)** shall be conducted with the Owner, design engineer, architect, general contractor, concrete supplier, concrete finisher, concrete pump subcontractor, materials testing engineer, and any others involved with the placing and finishing of the slab. Attendance is critical to review specifications and placement procedures and to assure quality expectations are met.

3403 Subgrade for slab-on-grade, including any stone base, shall be reviewed with the structural engineer to assure compliance with friction coefficients and other design criteria (sand cushions will not be allowed).

3404 A continuous vapor barrier (retarder) equal to 15 mil Stego Wrap shall be installed under slab. The place and finish contractor shall be able to demonstrate sufficient experience with finishing concrete on a vapor barrier. Vapor barrier placed on subgrade shall be capable of supporting reinforcing and concrete placement operations. Overlap and tape joints to assure seal. No vehicles or buggies, except laser screed, shall be allowed to drive on vapor barrier.

3405 Block-outs for interior columns shall be round. Concrete infill of block-outs shall be finished to match quality of floor slab. Alternate column isolation methods (i.e. diamond shaped block-outs) shall be submitted for review.

3406 Floor Flatness and Levelness testing will be performed at random within 24 hours of casting the slab. Values shall be no less than Ff 35 / Fl 30. (MLV - 25/17).

3407 Spacing of saw cut control joints in slabs shall not exceed 15'. Saw-cutting of control joints shall be performed as soon as the slab has cured to the point that "raveling" will not occur, but not later than 12 hours after finishing operations. Unless otherwise approved by the Architect, saw cuts are to be cut with a soft-cut saw to a depth of ¼ of the slab thickness. Remove saw dust immediately to eliminate dust ghosting. Control joint design, spacing, depth, etc., shall comply with relevant ACI Standards.

3408 Unless specifically approved by the Architect, concrete shall be placed by. Placed concrete shall receive a hard, dense burnished steel troweled finish.

3409 Finished concrete shall receive a one-coat application of curing compound, Sonneborn Kure-N-Seal, or equal, unless otherwise approved by the Architect. Alternate curing and sealing methods will be considered based on methods proven effective. The method shall be compatible with the subsequent application of floor coverings and treatments. The contractor will be required to clean any grease or oil stains from the slab prior to project completion. Only blue chalk shall be used for markings on slab. **The use of red chalk is prohibited.**

3500 Patching

3501 Any removal and replacement of the concrete slab shall meet the reinforcement, thickness, and subgrade preparation requirements of the existing slab. Backfill and subgrade shall be compacted to 95% of maximum dry density determined in accordance with ASTM D-1557. Dowel the new concrete patch to the existing slab with ½" smooth steel dowels, extending a minimum of 8" into slab at 18" on center, secured with epoxy o the end and a sleeved insert on the other. Use 4,000 psi (at 28 days) concrete for the pour

back. Pour back finish shall be as dense as adjoining surfaces. Saw-cuts for sanitary sewer line (or other items to the installed below floor) shall be made parallel and perpendicular to existing saw cut control joints (diagonal cuts in the floor slab are prohibited). Air-entrained concrete shall be used only for exterior, horizontal conditions.

3600 Saw-Cut Openings in Tiltwall Panels

3601 UNDER NO CIRCUMSTANCES SHALL ANY PROPOSED SAW CUT OPENINGS BE MADE IN THE EXTERIOR WALL WITHOUT THE NOTIFICATION OF OWNER. The structural engineer shall review proposed opening location. After the cut has been made, it shall be finished to match the surrounding concrete texture.

3700 Holes in Tiltwall Panels

3701 Holes cut in concrete wall panels, grade beams, retaining walls, etc. for piping, etc. shall be cut only with written approval of structural engineer, and with appropriate tools to ensure an even cut with clean edges. Holes larger than 2" in diameter shall be core drilled. Seal with Sonolastic NP 1 by Sonneborn or equal.

End of Division

DIVISION 4 – Masonry

4100 Exterior Accent Masonry

4101 Natural stone, face brick, or other masonry materials shall comply with applicable standards for quality. Provide locally produced, quarried, or manufactured materials where possible.

4102 A mock-up sample (approx. 48" x 48") shall be constructed on site that includes materials and conditions to be encountered in the building construction, including but not limited to color uniformity, joint conditions, and corner conditions. Mock up shall include masonry materials, along with other adjacent materials (storefront & glass, other accent materials, etc.).

4103 The first full panel of masonry built on this project shall be the standard for workmanship for issues such as head joint alignment that cannot be demonstrated on the smaller scale mock-up panel. Masonry Contractor shall notify the Architect upon completion for review and acceptance.

4104 Provide face brick as shown on drawings, King Size brick, colors to be selected. Solid brick with exposed surfaces finished for ends of sills and caps. ASTM C-216.

4105 Provide brick relief angles and expansion joints where indicated on drawings, per standard construction practices. Pre-formed expansion joint gaskets to be made from styrene-butadine rubber or PVC.

4106 Mortar and Grout:

A. Do not use masonry cement.
B. Do not use calcium chloride in mortar.
C. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions, and for other applications where another type is not indicated, use Type N Portland cement/lime by proportion method as follows:

1 bag Type I Portland cement	94 lb.
1 bag Type S hydrated lime	50 lb.
6 cu. ft. damp, loose, washed masonry sand	480 lb.

4107 Masonry Veneer Anchors: HB200 (provide only commercial ties, do NOT use residential ties)

4108 Flashing and Weep Holes:

A. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
B. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing before covering with mortar. Extend flashing 4 inches into masonry at each end and turn up 2 inches to form a pan.
C. Trim wicking material used in weep holes flush with outside face of wall after mortar has set.

4109 Clean masonry as work progresses. Remove mortar fins and smears from tooling joints. After mortar is thoroughly cured, remove large mortar particles, scrub, and rinse thoroughly with approved cleaner and clear water.

4110 Installation, general:

A. Cut masonry units with saw. Install with cut surfaces and, where possible, cut edges concealed.
B. Mix units from several different pallets as they are placed to produce uniform blend of colors and textures.

C. Stopping and resuming work: Rack back units; do not tooth.
D. Tool exposed joints slightly concave when thumbprint hard, unless otherwise indicated.
E. Keep cavities clean of mortar droppings and other materials during construction.
F. Contractor has the option of leaving out every third brick at the bottom of the wall until job completion, for cleaning and inspecting cavity, as an alternative to using Mortar Net.

04230 Structural Reinforced Unit Masonry

Refer to Structural Drawings for Structural Reinforced Unit Masonry Specification.

4300 Cast Stone

4301 Cast items in custom forms specifically made for this job. Submit shop drawings for approval by the Architect.

4302 Mix and cast stone using standard methods of the manufacturer. Final color to be selected.

4304 Deliver cast stone to site protected to insure that there will be no breakage, chipping, or soiling of any kind; and store protected, off ground.

End of Division

Division 5 – Metals

05120 Structural Steel

Refer to Structural Drawings for Structural Steel Specification.

05210 Steel Joists and Joist Girders

Refer to Structural Drawings for Steel Joists and Joist Girders

05320 Metal Deck

Refer to Structural Drawings for Metal Deck Specification.

5400 Roof Access Ladder

5401 Roof ladder shall be designed to meet all current OSHA safety regulations including appropriate rung configuration, safety cage, and intermediate landings (if applicable).

5402 Ladder is to be 18” wide with ¾” round rungs at 12” on ¼ x 3” runners. If ladder is free-standing, provide stiffener and/or column to stabilize ladder and prevent excessive mid-span deflection.

5403 Ladder is to be galvanized and/or painted depending on the service application.

End of Division

Division 6 – Woods and Plastics

6000 Wood Products

6001 Provide appropriate species, type, grade, and additive treatment (pressure treated, fire retardant, etc.) for all wood products used on the project to ensure longest possible service life of the wood products. Provide appropriate fasteners (galvanized fasteners, stainless fasteners, etc.) for the type of wood used.

6002 Wood products delivered to the site shall be stored and protected prior to being incorporated into the project, and then protected until waterproofing components can be installed, to avoid water damage.

6003 Provide 3/4" plywood telephone board (size to be 4’ x 8’, painted white).

6004 Provide preservative-treated materials as required for a roof system guarantee, and wood members in connection roofing, flashing, vapor barriers, and waterproofing; concealed members in contact with masonry or concrete; wood framing members less than 18 inches above grade; and wood floor plates installed over concrete slabs directly in contact with earth.

6005 Provide wood cant strip or prefabricated miter at expansion joints.

6006 Provide wood curbs and/or blocking for roof hatch as specified.

6100 Structural Wood Components

6101 The following considerations shall be observed:

A. Nailers: The nailers attached to the steel joists and girders shall be designed and installed in strict accordance with the steel joist/girder manufacturer's requirements, and/or shall be installed in the factory by the joist/girder supplier.
B. Purlins and Joists: The lumber size, spacing, and fasteners shall be installed per the design layout. Quality control measures shall be incorporated to assure that fasteners, connection hardware, spacing, and other requirements are adhered to.
C. Decking: Material specifications and thicknesses shall be designed by the structural engineer. End laps of individual decking components shall be staggered. Install spacer clips at but joints to allow for swelling of the material due to fluctuations in the moisture content of the materials. All fasteners shall be placed in strict accordance with the design requirements. Staples will NOT be allowed for roofing systems.
D. Protect the materials from water damage before and during the construction process.
E. All nailing operations, including automated systems, shall strictly adhere to requirements for quantity and pattern of fasteners. Nails that are out of alignment causing them to miss substrate shall be replaced to ensure specified connection strength. Local common practice shall not be cause to release contractor from obligation to have all nails penetrate substrate as intended.
F. Nailing penetration values shall be strictly adhered to.

06192 Prefabricated Wood Trusses and Bracing

Refer to Structural Drawings for Prefabricated Wood Trusses and Bracing Specification.

6200 Millwork and Case Goods

6201 Furnish and install cabinets where shown on floor plans. Cabinet materials and finishes to be as noted on drawings, and as selected by Owner. Base cabinets shall be 34" high with 4" toe kick, concealed hinges, and hardware as selected by Owner. Cabinets shall use ball bearing, telescoping glides. Interior of plastic laminate finished cabinets shall be white melamine surfaces with concealed screw heads.

6202 Countertops shall be as noted on drawings, or as selected by Owner.

6203 Architectural millwork and cabinetry shall be of a construction quality equal to that of the Architectural Woodwork Institute's (AWI) custom grade for flush overlay construction, or better. Work shall comply with all relevant provisions of applicable accessibility standards.

6204 Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating.

6300 Finish Carpentry

6301 Condition finish carpentry in installation areas for 24 hours before installing.

6302 Install finish carpentry level, plumb, true, and aligned with adjacent materials. Scribe and cut to fit adjoining work. Refinish and seal cuts.

6303 Install standing and running trim with minimum of joints practical, using full-length pieces from maximum lengths of lumber available. Stagger joints in adjacent and related trim. Cope at returns and miter at corners.

End of Division

Division 7 – Thermal and Moisture Protection

7000 Insulation

7001 Batt Insulation:
A. Batt insulation shall be foil faced except at plenum areas that do not require plenum rated insulation.
B. Provide insulation with appropriate thermal resistance (R-value) and vapor retarding characteristics to comply with energy code requirements.
C. Blanket materials to be of an R-Value as noted on drawings. All joints are to be taped with foil tape.

7002 Exterior Wall Insulation:
A. Provide medium density, polyurethane foam insulation in exterior stud wall cavities. Acceptable manufacturer: Icynene, Inc. Icynene MD-C-200, or equal.
B. Apply foam insulation to depth required to achieve cavity R-value as noted on drawings.
C. Apply per manufacturer's instructions.

7002 Roof Insulation:
A. All roof insulation shall be mechanically fastened for a minimum wind resistance of I-60 in the base system.

B. Provide R-value as noted on drawings of polyisocyanurate (Iso) insulation at all roof areas.
C. Tapered insulation and crickets may be EPS material.
D. Insulation placed on the roof must be covered the same day with the roofing membrane. Extra care must be taken to maintain and protect all roofing products to meet manufacturer's criteria.

7004 Acoustic Insulation:
A. Furnish and install 3½" un-faced fiberglass batt acoustic insulation in all interior partitions, U.O.N.

7200 Vapor Retarders and Vapor Barriers

7201 Vapor barrier/retarder shall be 15 mil Stego Wrap, or approved alternate. All joints to be taped with appropriate joint tape per manufacturer's recommendations.

7202 Where vapor barriers/retarders are to be used, slab shall be reinforced concrete with reinforcing steel designed to resist the additional curling stresses. Install vapor barrier/retarder directly below slab (no sand cushion).

7300 Standing Seam Metal Roofing and Metal Soffit

7301 Provide field-seamed, 24 gauge steel, pre-finished, standing seam metal roofing, and all required system components and accessories. Panels to be 16" wide with 2"

7302 Provide 24 gauge steel, 12" wide, smooth, pre-finished metal panel soffit with concealed fastening system, and all required system components and accessories.

7303 Provide a minimum of a 10-year, No Dollar Limit (NDL) warranty for labor and materials from the manufacturer, and a 2 year labor and materials warranty from the roofing subcontractor. Specific terms of the roof warranty shall be submitted to the Architect for review. Warranty exclusions such as a complete exception for wind damage are not acceptable. Warranties that "pro-rate or adjust" due to term are not acceptable.

7400 Membrane Roofing

7401 Roof system and details shall include all required system components and accessories appropriate for the given market conditions.
A. Unless otherwise required by local code or market requirements, roof system shall provide a minimum I-60 wind uplift resistance, FM Class I Fire Resistance rating, and U.L. Class A Fire Rating.
B. All roof systems shall have a minimum slope of ¼" per foot.
C. Provide a minimum of a 10-year, No Dollar Limit (NDL) warranty for labor and materials, and a two (2) year labor and materials warranty from roofing subcontractor. The specific terms of the roof warranty shall be submitted to the Architect for review. Warranty exclusions such as a complete exception for wind damage are not acceptable. Warranties that "pro-rate or adjust" due to term are not acceptable. For warranties, the terms and conditions of the construction contract shall take precedence over provisions of standard specification.

7402 Prior to commencing roofing operations, conduct a **pre-roofing meeting** with the owner, developer, architect, general contractor, subcontractor, and manufacturer's representative. At the completion of the project, the installation shall be certified by the manufacturer of the system.

7403 Unless specifically approved by the Architect, roof shall be a mechanically fastened, 45 mil **TPO (Thermoplastic Polyolefin)** single ply membrane system (including all required accessories) complying with manufacturer's standards and recommended details.
A. The fasteners for the membrane (and insulation) shall be painted white.
B. Roof membrane shall wrap up and over the parapet with a cap flashing.
C. Protection of roof areas exposed to high traffic conditions shall be provided by means of increased membrane thickness to 60 mils and/or providing walk pads from the access point to the areas where equipment is located.

7500 Roof Accessories

7501 Flashing and sheet metal applications shall be fabricated from a minimum of 24 gauge, galvanized steel or aluminum in the following applications:
A. Conform to specifications and recommended practices of SMACNA Architectural Manual for Fabrication and Installation.
B. All flashing material to be 24 gauge sheet metal, zinc coated steel and all joints must be watertight. Provide for thermal expansion and contraction in sheet metal items exceeding 15'.0".
C. Aluminum material may be utilized for downspouts, gravel stops, and similar applications. The aluminum material shall be shop applied baked enamel finish.
D. Pre-finished galvanized steel shall be used at gutters, cap flashing details, sill and head flashings. The material will be prefinished with a baked on enamel finish.
E. Galvanized or zinc coated flashings shall be utilized at counter flashing applications, equipment curb applications, and other areas not requiring aesthetic enhancement.

7502 Roof hatch to be Bilco Company, Type S, 2'-6" X3'-0" or equal. Roof hatch shall be 14 gauge metal, lockable, complete with insulated curb, and lock hasp.

7503 Crickets shall be incorporated at all locations such as roof hatches, skylights, and other places that obstruct water flow.

7504 Staples with tape application are prohibited – NO EXCEPTION.

7600 Fire Stopping

7601 All penetrations and terminations of fire rated assemblies shall be designed to meet all required code and design standards. The methods shall comply with assembly details required by UL and / or FM.

7602 Termination details that are in contact with building components subject to movement (thermal expansion / contraction, deflection loading, etc.) shall be designed to utilize a flexible fire stopping material that will accommodate the anticipated movement.

7700 Joint Sealants

7701 Provide sealants and joint fillers as required to ensure water tight building envelope.

7702 Concrete/Masonry joints shall be caulked with an appropriate silicone or polyurethane joint sealant material. The material may be moisture cured or catalyzed as appropriate for specific installation conditions. Ensure compatibility of joint design/width and properties of joint sealant.

A. Provide evidence that manufacturer performs a "pull test" of all sealants used on the project.
B. Clean and prime substrate as required to ensure adhesion of sealants.
C. Installation of sealant shall comply with all manufacturers' recommendations/requirements.
D. Provide appropriate depth of sealant and utilize correct tooling process to ensure good sealant bond with the substrate.
E. Provide open cell backer rod. Protect material to prevent backer rod from getting wet before the application and curing of the caulking material.
F. If sealant joints are to be painted, provide urethane sealants (do not use silicone sealants at joints to be painted). Select sealant color to match color of paint as closely as possible where sealant is to be painted.

7703 Glass System joints shall utilize the appropriate silicone sealant details as recommended by the aluminum framing system and glass manufacturers. Pull tests, primers, and all other installation protocol shall be followed in strict accordance with the manufacturer's specifications.

7704 Miscellaneous joints in the building envelope are to be installed utilizing proper joint design, materials, and installation methods. Under no conditions are acrylic latex sealants to be used in exterior applications or applications designed to serve any function other than an aesthetic termination from one material to another.

7705 Interior floor control joints are not to be filled unless directed by the Architect.

A. Provide one or two part polyurethane joint fillers at slab joints (control joints, as well as construction joints) not subject to traffic. Ensure compatibility of joint design/width and properties of joint sealant. Provide joint backing to ensure proper joint sealant depth and to prevent three sided adhesion. These types of sealant shall not be used in joint applications that require the sealant to provide load transfer properties.
B. Control joints and construction joints subject to traffic and designed for minimal movement shall be filled with flexible, semi-rigid epoxy joint filler such as MM-80 or Crete-Fill. The material shall be installed the full depth and width of the joint to provide full load transfer capability. Bond breaker tape shall be used in the bottom of the joint to reduce seepage and minimize three sided adhesion (backer rod or sand shall not be used). Joint filler shall be installed as long after the slab is cast as possible to allow for the curing movement of the slab to complete (preferably as part of the tenant build out).

7706 Install traffic grade polyurethane joint sealant at exterior concrete paving joints to limit water migration through the pavement to the sub grade. Ensure compatibility of joint design/width and properties of joint sealant.

7800 Weather Barrier

7801 Provide polyolefin weather barrier for above grade, vertical wall surfaces where the wall assembly may be exterior gypsum sheathing, exterior plywood sheathing, or OSB sheathing.

A. Weather barrier system to include: weather barrier membrane, seam tape, flashing, and fasteners.
B. Use sealants, adhesives, and primers recommended by manufacturer.

7802 Install 10' x 10' mock-up of weather barrier assembly, including all related accessories, for visual inspection by manufacturer's representative.

7803 Provide appropriate flashings at doors, windows, penetrations, masonry ties, shelf angles, foundations, etc.

7804 Acceptable manufacturer: Dupont, Tyvek.

End of Division

Division 8 – Doors / Glass Systems

8000 Hollow Metal Doors, Frames, and Hardware

8001 Provide doors and frames complying with the Steel Door Institute Guidelines. (SDI-100).

8002 Hollow metal frames used on exterior applications shall be welded, 16 gauge galvanized steel. Knock down frames may be used for interior applications. Fire rated assemblies are to be labeled with the appropriate UL label and shall not to be modified.

8003 Exterior doors to have face sheets formed of cold rolled A-36, 18 gauge steel; and interior hollow metal doors to have cold rolled face sheets of 20 gauge steel; 1¾" thick, flush face.

8004 Hollow metal doors shall be insulated and thermally isolated as required (exterior), and shall be appropriately labeled for required fire rating. Door sizes shall be coordinated with the equipment requirements for pump rooms, electrical rooms, and other locations where equipment may need to be removed and replaced over the life of a building. Head condition at doors shall not be channeled. Provide louvers in doors where required for ventilation.

8005 Provide door hardware to all exterior hollow metal doors and exits. Door hardware shall comply with ADA and other accessibility regulations. Door hardware shall include all required locksets, passage sets, theft-proof hinges, stops, silencers, thresholds, weather-stripping, and closers required to ensure proper and appropriate function of the building. The hardware quality shall be heavy duty, Schlage 'D'-series hardware, or equal. Provide closers at all exterior doors, fire exit doors, and mechanical room doors. Hinges shall be heavy duty, stainless steel, ball bearing type for industrial use. Provide rain drip immediately above (at head of frame) all exterior doors. Thresholds shall be set in full bed of sealant to prevent water infiltration into building.

8200 Storefront and Glass Systems

8201 Provide aluminum and glass storefront systems appropriate for the intended application at all window areas.

A. Storefront systems shall be equal to Kawneer Co. "Trifab 450" 1- ¾" x 4 ½ C-Slot glazing system.
B. Framing system shall have AAM 21C22A42 Architectural Class I Anodic Coating, clear anodized.
C. Provide concealed fasteners for all aluminum framing installations.
D. At new entrance doors, provide medium stile doors with push/pull, pivots, closers, weather-stripping/sweeps, and dead bolt lock (dead bolt cylinder shall ave interchangeable core and thumb turn at interior). Provide panic exit hardware where required by code.
E. Provide crash bars where required at pedestrian areas.

8202 Provide 1" insulated, low-e glass, color to be selected.

8203 Conduct a pre-installation conference with the architect, manufacturer, contractor, and subcontractor to review all shop fabrication details and field installation details. Quality control provisions shall include a field water test of the system by the contractor. Protect the finished work to prevent damage to framing, finish, or glass components. Any damaged material will be replaced.

8204 Design layout of framing members such that the incorporation of future additional storefront entrance points can be achieved with minimal rework of the original system.

8205 All framing and glazing color selections shall be submitted to the Architect for review.

8300 False Mullions

8301 Where interior drywall partitions meet the exterior window wall between vertical mullions, furnish and install aluminum "false" mullions finished to match the exterior storefront with neoprene gasket at glass and wall end cap.

8400 Interior Doors and Frames

8401 Furnish and install 3'-0"x7'-0"x1¾" (or as noted on plans) solid core, Red Oak (or as selected by Owner) stain grade flush, wood doors in clear anodized aluminum frames or painted HM frames (or as noted on plans), with 1-1/2 pairs of butts per door U.O.N. Doors receiving closer shall receive ball-bearing butts.

8500 Interior Door Hardware

8501 Furnish and install door hardware as selected by Owner. The door hardware shall have a satin chrome 626 finish, or as selected by Owner. Furnish and install weather-stripping, closers, door bottom sweeps where required. Furnish and install closers at all multi-fixture toilet room doors. The closer shall be installed on the toilet room side of the door. Furnish and install closers at all 1-hr. rated doors in 1-hr. rated partitions. Hardware shall comply with applicable provisions of the T.A.S. regulations. If existing door hardware does not comply with accessibility standards, replace existing hardware with new compliant hardware.

8600 Interior window Frames / Glass (Excluding Storefront Systems)

8601 Interior windows shall be ¼" clear tempered in clear anodized frames to match door frames.

8800 Mirrors

8801 Furnish and install 4' high x ¼" thick plate glass mirrors with two coats silver and electroplated copper backing, and polished edges (or as selected by Owner) at all lavatories. The mirror shall be the length of the lavatory top set directly on top of the splash. Mirrors shall be mounted per T.A.S. requirements.

End of Division

Division 9 - Finishes

9000 Metal Framing / Drywall

9001 Full Height Drywall Partitions (as noted on drawings): Wood studs with one layer of 5/8" Type "X" gypsum board on each side from the floor to the floor deck above. The stud size and spacing shall be per local code requirements. Drywall installed above an acoustical ceiling shall be fire-taped and screws spotted.

9002 Interior Drywall Partitions (as noted on drawings): All interior walls shall be built to 6" above grid (U.O.N.) Furr perimeter and interior columns to 6" above the grid.

9003 Where drywall partitions are used, all framing materials and practices shall comply with guidelines and standards established by the United States Gypsum Association.

9100 Paint / Textured Coatings

9101 Paint materials shall be provided based on the application, substrate, and the conditions of service (interior, exterior…).

9102 All steel, flashings, doors, frames shall receive primer coat plus two finish coats of appropriate semi-gloss enamel paint.

9103 All overhead doors to have factory painted finish in manufacturer's standard "white" color.

9104 All paint to be factory mixed colors. Field mixing is not allowed.

9105 The painting and coating product submittals shall include appropriate detail concerning surface preparation, priming, and coating, including the number of coats and thicknesses of each.

9106 All color selections are to be selected by the Owner.

9107 All finished product shall be well bonded to the substrate, have even and complete coverage, and be free from surface cracking due to applying the material in lifts that are too thick.

9108 Paint all parking lot stripes and symbols with Standard Paints, Inc., "Brite Stripe" chlorinated rubber traffic paint or alternate material specifically designed for pavement markings. White is the preferred color for parking lot striping. Fire lanes shall be red with white lettering or per fire code requirements.

9200 End Caps

9201 Where partitions meet window mullions, furnish and install an aluminum “wall end cap” finished to match storefront.

9300 Wainscot

9301 Toilet room walls shall receive 48” high porcelain tile wainscot at all wet and side walls (or as selected by Owner). Walls behind mop sinks and laundry trays shall receive a 4’x4’ FRP wainscot along each side of the sink in contact with the wall. All wet walls shall be built with water resistant drywall (green board). Where porcelain tile is used for the floor, wainscot shall be tile to match adjacent surfaces.

9400 Acoustic Ceiling Tile

9401 Furnish and install ceiling tile as noted on drawings.

9500 Acoustic Ceiling Tile Suspension System

9501 Furnish and install ceiling grid system as noted on drawings. The grid color shall be white.

9600 Floor Finishes

9601 Carpet to be selected by Owner. Carpet shall be direct glue down except as requested by Owner)..

9603 Provide sheet vinyl or vinyl strip flooring where noted on drawings, as selected by Owner.

9604 Provide porcelain tile where noted on drawings, and as selected by Owner. The tile floor shall be cleaned after installation to remove excess mortar and grout. The grout shall be sealed per manufacturer’s recommendation.

9800 Rubber Base

9801 Provide 4” high, top set rubber base as manufactured by Burke, Roppe, or Tarkett, where noted on drawings. Color to be selected by Owner.

9900 Paint / Textured Coatings

9901 Paint materials shall be provided based on the application, substrate, and the conditions of service. On walls receiving a textured finish, apply one (1) coat of interior eggshell latex paint, Sherwin Williams (ProMar 200) or equal. Toilet and shower rooms and walls at coffee bars or break counters shall receive one (1) coat of latex semi-gloss enamel over one (1) coat of PVA sealer. Walls receiving wall covering shall receive one (1) coat of sealer.

End of Division

Division 10 - Specialties

10100 Signage - Exterior

10101 Building identification signage shall approved by Owner. Sign design, size, and location shall comply with local code/ordinance, and shall be approved by local authorities.

10102 Provide pole or wall mounted signs designating accessible parking spaces, along with any miscellaneous signage required by, and compliant with, the Texas Accessibility Standards.

10103 Provide fire lane signs as required.

10200 Toilet Accessories

10201 Hand Dryer: XLERATOR Hand Dryers, Model #XL-BW-1.1N, with noise reduction nozzle and #40502 Recess Kit.
Paper Towel Dispenser: Bradley Model 237 semi recessed.
Toilet Paper Holder: Bradley Model 5224 double toilet paper holder.
Grab Bars: Bradley Models 8120-00136 (rear) and 8120-00142 (side) stainless steel per T.A.S.
Napkin Disposals: Bradley Model 4781-15 sanitary napkin disposals in each woman’s toilet stall U.O.N.
Restroom Coat Hook: Bradley Model 9124 satin-finish stainless steel surface-mounted double robe hook.
Janitor Room Mop Holder: Bradley Model 9933 stainless steel utility shelf with mop/broom holders and rag hooks.

10300 Signage - Interior

10301 Furnish and install all handicap and exit signage as required by code. Comply with applicable accessibility standards for design of signage and for mounting details/locations.

10400 Miscellaneous Specialties

10401 Provide Knox box(es) as required by fire department.

End of Division

Division 11 – Equipment

11000 Central Vacuum System

11001 Provide central vacuum system with 2 stage, 4.8 hp motor; self-cleaning permanent fabric filtration with HEPA rated media; 7 gallon capacity. Provide VacPan Automatic Dustpan Inlet at Labs. Acceptable manufacturer: NuTone, or equal.

End of Division

Division 12 – Furnishings

12000 Furnishings

12001 Window treatments (mini-blinds, manual and motorized), walk off mats, and other furnishings shall be selected by the Owner.

End of Division

Division 15 – Mechanical Systems

Refer to Mechanical and Plumbing Drawings and Specifications.

Division 16 – Electrical Systems

Refer to Electrical Drawings and Specifications.

SECTION 02372 - DRILLED PIERS

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Furnish all labor, materials, services and equipment as required in conjunction with or properly incidental to drilling of piers as described herein and/or as shown on the Drawings.

1.02 RELATED DOCUMENTS:

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

1.03 CODES AND STANDARDS:

A. The work described in this Section, unless otherwise noted on the Drawings, or herein specified, shall be governed by the latest editions of the following codes or specifications.

1. ACI 301, "Specifications for Structural Concrete for Buildings".

2. ACI 304, "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".

3. ACI 305, "Hot Weather Concreting".

4. ACI 306, "Cold Weather Concreting".

5. ACI 311, "ACI Manual of Concrete Inspection".

6. ACI 318, "Building Code Requirements for Reinforced Concrete".

7. ACI 336.1, "Standard Specification for the Construction of End Bearing Drilled Piers".

1.04 MEASUREMENT AND PAYMENT:

A. The Contract sum shall include all labor, materials, overhead and profit for completing drilled piers including removal of spoil. Cost of providing and placing of casings is to be included in base Contract. Top of bearing stratum shown on Contract Drawings is for estimating purposes only. Pier drilling log prepared by the Owner's Testing Laboratory shall be used to adjust the Contract amount for greater and lesser pier depths, based on the actual top of bearing stratum elevation, or greater depths due to presence of sand pockets or clay seams encountered during the drilling process. Payment will not be made for pier penetrations into bearing stratum greater than that required by the Contract Documents, unless approved by Owner and Architect.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Reinforcement: Refer to Section 03200.

B. Concrete: Refer to Section 03300.

PART 3 - EXECUTION

3.01 DRILLING:

A. Schedule pier drilling so piers will be filled with concrete immediately after drilling. Fill each pier with concrete within eight (8) hours after completion of drilling of same.

B. Drill piers with power auger foundation drilling rig designed for that purpose. Locate piers to within one inch (1") maximum tolerance horizontally in any direction. Drill piers to size and depth shown, vertically, with maximum acceptable tolerance from plumb in any shaft, measured in center of shaft, not to exceed one inch (1") in any ten feet (10') with a maximum of two inches (2"). Piers drilled outside of maximum tolerance will be rejected.

C. If caving or substantial amounts of ground water are encountered, use casings to prevent caving and exclude water. Install casing sufficient distance into bearing strata to insure watertight seal.

D. If sand pockets or clay seams are encountered at the bottom of the pier hole, the pier depth must be increased to avoid bearing the pier within the sand or clay layer. The amount of increase in the pier depth shall be determined on an individual basis for each pier, and as recommended by the geotechnical engineer present on site during the drilling operation.

3.02 PUMPING AND CLEANING:

A. After pier holes have been drilled to proper depth and cutting edge of casing is seated, if required, pump water out.

B. Clean bottom of pier excavations of loose material and foreign matter and receive approval of Testing Laboratory before depositing concrete.

3.03 PLACING REINFORCING STEEL AND CONCRETE:

A. Do not place steel or concrete until pier holes have been inspected and approved by Testing Laboratory.

B. Maintain minimum three inch (3") clearance between bottom of excavation and sides of excavation and reinforcement. Reinforcing to extend to within 2" of the top of the pier unless noted otherwise.

C. Provide steel dowels as detailed or scheduled. Secure reinforcement, including dowels, in place, free of contact with sides of excavations.

D. Tremie concrete placed in excavations where concrete fall would be greater than 8'-0".

3.04 REMOVAL OF CASING:

A. Prior to breaking seal between temporary casing and underlying strata, static head of plastic concrete shall be sufficiently above ground water head to prevent water and caving soils from entering hole during removal of casing. Once seal has been broken, temporary casing may be slowly removed in a vertical direction (no rotation permitted) while additional concrete is placed to top of casing.

3.05 IMPROPER INSTALLATION:

A. The cost of any and all changes due to improper installation of drilled piers shall be paid by the Contractor. This shall include Architect's and Engineer's additional services made necessary by such failure, as well as costs for labor and materials.

3.06 FIELD QUALITY CONTROL AND TESTING:

A. Soils Testing Laboratory shall make continuous inspections of pier drilling operations to determine that proper bearing stratum is obtained and utilized for bearing and that shafts are properly clean and dry before placing concrete.

B. Furnish complete pier log, showing the diameter, top and bottom elevations of each pier, casing required or not required, actual penetration into bearing stratum, elevation of top of bearing stratum, reinforcement and any and all observed irregularities, deficiencies or deviations from the Contract Documents.

END OF SECTION

SECTION 03100 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Includes furnishing all materials, equipment, transportation and facilities, and performing all labor necessary for constructing concrete formwork.

1.02 CODES AND STANDARDS:

A. The Work described in this Section, unless otherwise noted on the Drawings, or herein specified, shall be governed by the latest editions of the following codes or specifications.

1. ACI 301, Specifications for Structural Concrete of Buildings.

2. ACI 318, Building Code Requirements for Reinforced Concrete Buildings.

3. ACI 347, Recommended Practice for Concrete Formwork.

4. U.S. Product Standard for Softwood Plywood, Construction and Industrial PS-1.

5. Timber Construction Manual, American Institute of Timber Construction.

6. Design of Wood Formwork for Concrete Structures, National Forest Products Association.

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01340.

B. Shop Drawings: Submit a diagram of proposed construction joints not indicated on Drawings prior to or concurrent with reinforcing steel shop drawings.

1. Shop drawings will be reviewed for proposed construction joint locations with respect to aesthetic criteria and general design conformance only.

C. Product Data: Submit complete manufacturer's product data sheets for each specified product.

1.04 DESIGN:

A. The design and engineering of formwork and shoring, as well as its construction, shall be the responsibility of the Contractor.

B. Design criteria shall conform to ACI 347, Chapter 2.

1.05 ALLOWABLE TOLERANCES:

A. Except when close coordination and fitting of various trades' work precludes allowance of tolerance, maximum total permissible deviations from established line, grades and dimensions shall conform to ACI 347, Section 2.2.1. Set and maintain forms in such manner as to ensure completed work within specified tolerance limits

B. Variation in location of embedded structural items unless provided with sleeves or other means of adjustment: 1/4".

1.06 STORAGE OF MATERIALS:

A. Store form materials and accessories on dunnage and under cover with protective sheeting.

1.07 COORDINATION:

A. Notify responsible trades of schedules of concrete pours so as to allow adequate time for installation and coordination of their work.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Forms: Wood, metal and other approved material that will not adversely affect surface of concrete and will provide or facilitate obtaining specified surface finish:

1. Wood forms for unexposed concrete surfaces shall be built of No. 2 Common Southern Yellow Pine Lumber or other material of equal qualifications, of sufficient thickness to be capable of sustaining the loads to be imposed thereon, dressed to uniformly smooth contact surfaces and so constructed as to be readily removable.

2. Wood forms for exposed concrete surfaces shall be constructed of Commercial Standard Douglas Fir, moisture-resistant, concrete form plywood, not less than five (5) ply, and at least nine-sixteenths inch (9/16") thick, with one smooth face.

3. Metal forms shall be clean, unpainted and in good condition. Forms shall at all times be straight to provide members of the widths and depths required. Damaged or indented forms will not be acceptable.

4. Rustications and bevels in exposed concrete shown on the Drawings shall be formed with Northern White Pine. All rustication strips shall be milled so that the edges are smooth and free from sawmarks or other irregularities.

B. Form release agent shall be non-residual, non-staining chemical release agent containing no kerosene, meeting Corps of Engineer Specification CE-204 requirements. Test for non-staining of concrete.

C. Corner Chamfer: 3/4 inch polyvinyl chloride form strip equal to CSF type as manufactured by The Burke Company.

D. Form ties for exposed concrete surfaces shall be manufactured to allow a positive break back of no less than one inch (1") inside the concrete surface. Ties shall be equipped with a plastic cone of not less than five-eights inch (5/8") diameter and one inch (1") long which will completely cover the hole and prevent the leakage of any mortar. Form ties for unexposed surfaces shall be bolt rods or patented devices having a minimum tensile strength of three thousand (3,000) pounds when fully assembled. Ties shall be adjustable in length and free of lugs, cones, washers or other features which would leave a hole larger than seven-eights inch (7/8") in diameter, or depressions back of the exposed surface of the concrete. Ties shall be of such construction that, when the forms are removed, there will be no metal remaining within one inch (1") of the finished surface of the concrete.

E. Form Sealer: Synthex by Industrial Synthetics Corp, or Pre-Form by Nox-Crete.

F. Compressible Filler: Premolded plastic strips, non-asphaltic, ASTM D1752,Type 1.

G. Construction Joint Form: The Burke Company "Keyed-Kold Joint" or equal.

H. Vapor Retarder: 10 mil thick Stego Wrap Class A, maximum moisture vapor permeability of 0.036 perms per ASTM E96.

I. Void Forms: Sure Void Products, Inc.

PART 3 - EXECUTION

3.01 MATERIAL STORAGE:

A. Form material shall be delivered to the job site as far in advance of its use as is practical, and shall be carefully stacked clear of the ground in such a manner as to facilitate air drying.

3.02 INSTALLATION:

A. All concrete members shall be adequately shored to safely support all loads and lateral pressures outlined in "Recommended Practice for Concrete Formwork" (ACI 347), without distortion, excessive deflection and other damage.

B. All necessary forms, centering, shores and molds shall be built to conform to the shapes, lines and dimensions of the various members of concrete construction, as shown or scheduled on the Drawings. They shall be sufficiently tight and so substantially assembled as to prevent bulging or the leakage of mortar. All forms shall be assembled to facilitate their removal without damage to the concrete.

C. Provide temporary openings at the bottom of cast-in-place walls, columns and elsewhere as required to facilitate cleaning, drainage and inspection.

D. Construct forms with such care as to produce concrete surfaces which will not have unsightly or objectionable form marks in exposed (concrete) surfaces. Lumber once used as forms shall have all contact surfaces thoroughly cleaned before reuse.

3.03 FORM TIES:

A. Form ties shall be employed in such places and at such intervals as to securely hold the forms in position during the placing of concrete, and to withstand the weight and pressure of the wet concrete. Ties of a type intended to be entirely removed shall be coated with release agent to safeguard against damaging the concrete during such removal. The use of wire ties will not be permitted.

3.04 WOOD STRIPS, BLOCKING AND MOLDINGS:

A. Place in the forms wood strips, blocking, molding, nailers, etc., as required to produce the finished profiles and surfaces shown on the Drawings and to provide nailing for wood members or other features required to be attached to concrete surfaces in such manner. Coat wood strips, blocking, and moldings with release agent.

3.05 CHAMFERS:

A. All exposed external angels of concrete members shall have 3/4" chamfer strips placed in the forms to relieve the angles.

3.06 FORM COATING:

A. Treat forms with release agent. Wipe excess off the surface of forms, leave forms just oily to touch. Assure that release agent is not applied to reinforcing steel nor allowed to contact hardened concrete against which fresh concrete will be placed.

3.07 CONSTRUCTION JOINT:

A. Except as otherwise specifically indicated on the Drawings, each concrete member shall be considered as a single unit of operation, and all concrete for the same shall be placed continuously in order that such unit will be monolithic in construction. Should construction joints prove to be absolutely unavoidable, the same shall be located at or near the midpoints of spans.

B. Additional construction joints shall not be made under any circumstances without prior evaluation by the Architect. All construction joints must be either plumb or level. Provide appropriate keys and dowels in all construction joints, whether horizontal or vertical.

3.08 JOINT TREATMENT:

A. Gasket, plug, tape or caulk joints, gaps and apertures in exposed concrete forms to positively prevent leakage. Form joints allowed only where indicated on shop drawings. Where possible, locate joints behind rustication. Apply joint treatment within 24 hours of scheduled pour.

3.09 CLEANING:

A. Immediately before placing concrete, clean forms free of chips, wire clippings and other debris.

3.10 INSERTS AND ACCESSORIES:

A. Make provisions for required installation of accessories, bolts, hangers, sleeves, anchor slots and inserts cast in concrete.

B. Obtain templates or instructions for installation of items.

C. Place expansion joint fillers where detailed.

3.11 MISCELLANEOUS:

A. Construct forms for any and all items of concrete work required for or in connection with the satisfactory completion of the project, whether each such item is specifically show or referred to or not.

B. Do not sleeve any columns, beams, slabs or joists unless such sleeves are indicated on the Structural Drawings, or are previously approved on Shop Drawings by the Structural Engineer.

3.12 REMOVAL OF FORMS:

A. Forms shall not be removed until the concrete has adequately hardened and set. Clamps or tie rods may be loosened twenty-four (24) hours after the concrete is placed; ties, except for a sufficient number to hold the forms in place, may be removed at that time. Through wall ties that are to be wholly withdrawn shall be pulled toward the inside face of the respective wall or beam. Cutting ties back from the face of the concrete will not be permitted, and care shall be exercised to avoid spalling concrete surfaces.

B. Formwork for concrete members that support the weight of concrete shall remain in place until the concrete has reached 75% of its specified 28-day strength, unless otherwise specified or permitted.

C. Under normal conditions, the minimum period of time to be allowed to elapse before forms may be removed shall be as indicated in ACI 347, but its observance shall not operate to relieve the Contractor of the responsibility for the safety of the structure. Deviations shall be submitted to and reviewed by the Architect prior to removal of forms.

D. When the temperature falls below forty degrees Fahrenheit (40 degrees F.), the forms shall remain in place an additional period equal to the time the structure has been exposed to such lower temperature. Adequate measures shall be taken to protect the concrete from cold weather conditions.

E. Adequately reshore members subject to additional loads during construction to support both member and construction loads in a manner that will protect member from damage.

F. When reshoring is required, the operations shall be planned in advance and shall be the responsibility of the Contractor.

G. Contractor shall pay for and have Testing Laboratory make additional test cylinders to confirm strength requirements for early form recovery. Reshore before removing original shoring.Reshoring shall remain in place until members have attained required compressive strength, or as long as required to support additional construction loads.

3.13 FORM REUSAGE:

A. Thoroughly clean surfaces of forms and remove nails before reuse. Do not reuse damaged or worn forms. Inspect forms and re-tighten rustications. Remove traces of joint treatment and where required for taping joints, remove traces of release agent with MEK solvent.

B. Recoat contact surfaces of forms and liners with a light spray coat of release agent. Do not apply until after joint treatment is complete.

END OF SECTION

SECTION 03200 - REINFORCING STEEL

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Includes furnishing all materials, equipment, transportation, and facilities, and performing all labor necessary for preparation and submittal of shop drawings, furnishing and placing reinforcing.

1.02 RELATED DOCUMENTS:

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

1.03 CODES AND STANDARDS:

A. The work described in this section, unless otherwise noted on the Drawings or herein specified, shall be governed by the following Codes or Specifications:

1. ACI 301, "Specification for Structural Concrete for Buildings".

2. ACI 315, "Manual of Standard Practice for Reinforced Concrete".

3. ACI 318, "Building Code Requirements for Reinforced Concrete".

4. ASTM A185, "Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement".

5. ASTM A615, "Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement".

6. ASTM A706, "Standard Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement".

7. Concrete Reinforcing Steel Institute, "Manual of Standard Practice".

1.04 ALLOWABLE TOLERANCES:

A. Fabricating: Conform to ACI 315.

B. Placing:

1. Concrete cover to formed surfaces: Plus or minus 1/4".

2. Minimum spacing between bars: Plus or minus 1/4".

3. Top bars in slabs and beams:

a. Members 8" deep or less: Plus or minus 1/4".

b. Members more than 8" but not over 2'-0" deep: Plus or minus 1/2".

c. Members more than 2'-0" deep: Plus or minus 1".

d. Crosswise of members: Space evenly within 2" of stated separation.

e. Lengthwise of members: Plus or minus 2".

C. Maximum bar relocation to avoid interference with other reinforcing steel, conduits or other embedded items: 1 bar diameter.

1.05 SUBMITTALS:

A. Shop Drawings: Submit shop drawings and installation drawings including complete bending diagrams, assembly diagrams splicing and laps of bars, shapes, dimensions and details of bar reinforcing and accessories.

1. Show diagrammatic elevations of walls at scale large enough to clearly show position and erection marks of marginal bars, around openings, dowels, splices, etc., for these bars.

2. Show complete layout plan for each layer of reinforcing of slabs and beams showing number, arrangement, spacing, location, marking, orientation, etc. of reinforcement required for layer being described.

B. Mill Test Reports: Certified copies, evidencing compliance with the requirements of these Specifications, shall be delivered to the Architect and Engineer with all deliveries of reinforcing steel.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver reinforcement to project site in bundles marked with metal tags indicating bar size, length and mark.

B. Unload reinforcing carefully to prevent damage. Store above ground in dry, well drained area and protect from mud, dirt, paint, corrosion, etc.

1.07 SCHEDULING/SEQUENCING:

A. Coordinate Work of this Section with work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Reinforcing Bars: ASTM A615, new, deformed billet steel bars, domestic manufacture, Grades 60 and/or 40 as indicated on Structural Drawings. All reinforcement specifically noted as being welded shall be domestic steel conforming to ASTM A706.

B. If domestic steel reinforcing bars are unavailable, foreign bars may be used if mill certificates are submitted indicating compliance with domestic steel standards.

C. Welded Wire Fabric Reinforcing: ASTM A185, new, domestic manufacturer, steel wire spot welded at intersections and of sizes indicated.

D. Metal Accessories: Include spacers, chairs, bolsters, ties and other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place, conforming to the requirements of CRSI "Manual of Standard Practice for Detailing Reinforced Concrete Structures" and ACI 315. Metal accessories shall be plastic protected where legs will be exposed in finished concrete surfaces. Plastic protection shall be the color of the concrete.

E. Bar supports for concrete resting on earth shall be precast briquettes, having tie wires embedded therein, or Individual High Chairs No. HCP with welded plates on bottom as manufactured by Hohmann & Barnard, Inc.

F. Tie Wire: FS QQ-W-461, black annealed steel, 16 ga. minimum.

2.02 FABRICATION:

A. In accordance with CRSI "Manual of Standard Practice" and ACI 315.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Cleaning: Before placing in work thoroughly clean reinforcement of loose rust, mill, scale, dirt, oil, and other coating which might tend to reduce bonding. Reinspect reinforcing left protruding for future bonding, or following delay in work, and reclean if necessary.

3.02 INSTALLATION:

A. Bar Placement: In accordance with ACI 301, ACI 315, ACI 318, and CRSI "Manual of Standard Practice".

B. Bending: Bend bars cold; do not heat reinforcing or bend by makeshift methods. Discard bent, kinked or otherwise damaged bars.

C. Splices: In accordance with ACI 315 and the Contract Documents.

D. Placing: Reinforcement shall be accurately placed and securely saddle tied in accordance with CRSI recommended practice with No. 16 gauge black annealed wire, and shall be rigidly held in place during the placing of the concrete by means of metal chairs or spacers.

1. Bars in concrete walls and columns shall be held in position, and to proper clearance, by means of concrete or metal spacers made especially for the locations where spacers are required.

2. Bars in footings, beams and slabs shall be held to exact location during placing of concrete by spacers, chairs, or other necessary supports.

E. Supports: In accordance with ACI 301 and ACI 315 for number, type, spacing and placing.

F. Protection: Conform to ACI 318, Chapter 7.

3.03 WELDING:

A. No welding of reinforcing steel will be permitted unless specifically indicated on the Drawings.

B. Welding of reinforcing steel shall conform to AWS D1.4.

3.04 FIELD QUALITY CONTROL:

A. If reinforcing steel is purchased direct from a United States mill, manufacturer's test sheets will be sufficient. Steel supplier shall furnish mill certificate reports.

B. If steel is from an undetermined origin or manufacturer's test sheets or mill certificate reports are unavailable, perform tension and bending tests on three separate samples of each size of bar for every five tons of each type of steel as specified in the appropriate ASTM Specifications. Contractor shall furnish all material for testing and pay for all such tests.

C. Perform visual inspection prior to placement of size, type and quality of materials.

D. Observe and report on placement of reinforcement, including size, quantity, vertical location, horizontal spacing, correctness of bends, splices, clearance between bars and forms, firmness of installation, and security of supports and ties, immediately prior to concreting.

END OF SECTION

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Furnish all labor, materials, services and equipment as required in conjunction with or properly incidental to placing of concrete as described herein and/or as shown on the Drawings.

1.02 CODES AND STANDARDS:

A. The Work described in this Section, unless otherwise noted on the Drawings, or herein specified, shall be governed by the latest editions of the following codes or specifications.

1. ACI 211.1-81, "Recommended Practice for Selecting Proportions of Normal Weight Concrete".

2. ACI 301, "Specifications for Structural Concrete for Buildings".

3. ACI 304, "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".

4. ACI 305, "Hot Weather Concreting".

5. ACI 306, "Cold Weather Concreting".

6. ACI 309, "Standard Practice for Consolidation of Concrete".

7. ACI 311, "ACI Manual of Concrete Inspection".

8. ACI 318, "Building Code Requirements for Reinforced Concrete".

9. ASTM C33, Standard Specification for Concrete Aggregate.

10. ASTM C94, Standard Specification for Ready-Mix Concrete.

11. ASTM C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

12. ASTM C150, Standard Specification for Portland Cement.

13. ASTM C260, Standard Specification for Air-Entraining Admixtures.

14. ASTM C330, Standard Specification for Lightweight Aggregates for Structural Concrete.

15. ASTM C494, Standard Specification for Chemical Admixtures for Concrete.

16. ASTM C595, Standard Specification for Blended Hydraulic Cements.

17. ASTM C618, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.03 QUALITY ASSURANCE:

A. Source Quality Control:

1. Concrete production facilities shall meet the requirement for certification by the National Ready Mixed Concrete Association.

2. Concrete batchers shall be completely interlocked semi-automatic or automatic batchers, as defined by the Concrete Plant Manufacturers Bureau.

3. Concrete batchers shall have graphic, digital, or photographic recorders, which shall register both empty balance and total weight (or volume of water or admixture) of each batched material, time to the nearest minute, date, identification of batch, and numerical count of each batch. Copies of the record shall be furnished to the Testing Laboratory.

4. The Testing Laboratory shall provide concrete batch plant inspection as specified in Section 01410.

B. Concrete Mix Design Criteria:

1. Design concrete mixes in accordance with ACI 318.

2. For each concrete mix type proposed, make trial mix using aggregate proposed.

3. Determination of required average strength above specified strength shall be in accordance with ACI 318.

4. Make advance tests of trial mixes with proposed materials. Mold and cure test cylinders in accordance with ASTM C39. Do not place concrete on project until laboratory reports and results of confirmation cylinder tests have been evaluated by the Testing Laboratory and results indicate that proposed mixes will develop required strengths.

5. Testing Laboratory shall furnish the Architect with a written evaluation of each proposed concrete mix design submitted by the Contractor.

6. Check mix designs and revise if necessary wherever changes are made in aggregates or in surface water content of aggregate or workability of concrete. Slump shall be minimum to produce workable mix. Laboratory shall prescribe maximum quantity of water.

1.04 SUBMITTALS:

A. Mix Designs: The Contractor shall submit proposed mix designs, including confirmation cylinder test results, in accordance with ACI 318 to the Testing Laboratory for evaluation a minimum of 14 days prior to placing concrete. Show:

1. Proportions of cement, including fly ash content, fine and coarse aggregates, and water.

2. Combined aggregate gradation.

3. Aggregate specific gravities and gradations.

4. Water-cement ratio, design strength, slump and air content.

5. Type of cement and aggregates.

6. Type and dosage of admixtures.

7. Type, color and dosage of integral coloring compounds, where applicable.

8. Special requirements for pumping.

9. Range of ambient temperature and humidity for which design is valid.

10. Any special characteristics of mix which require precautions in mixing, placing, or finishing techniques to achieve finished product.

B. Mix designs based on record of past performance in accordance with ACI 301 Method 2, may be submitted in lieu of mix designs required above, provided all necessary information is included.

C. The Contractor shall furnish duplicate delivery tickets for each load of ready-mix concrete delivered to site, in accordance with ASTM C94. Show batch weights on each ticket.

D. The Contractor shall furnish mill test reports on an as-used basis for each type and brand of cementitious material used, including fly ash.

E. The Testing Laboratory shall furnish a statistical analysis for each class of concrete placed on the project as specified in this section.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mix and deliver concrete to project ready-mixed in accordance with ASTM C94. Mix concrete a minimum of 70 revolutions of transit mix drum at mixing speed. A minimum of 40 revolutions shall be at the production plant.

B. Schedule delivery so that continuity of any pour will not be interrupted for over 15 minutes.

C. Place concrete on site within 90 minutes after proportioning materials at batch plant.

1.06 JOB CONDITIONS:

A. Hot Weather Concreting:

1. Follow ACI 301 and ACI 305.

2. Provide retarding type admixture conforming to ASTM C494, Type A or D in accordance with manufacturer's recommendations.

3. Maximum concrete temperature shall not exceed 95 degrees F at time of placement.

a. Concrete with temperatures above 90 degrees F shall be placed only if a high range water reducer (super plasticizer) is added to the mix as directed by the Testing Laboratory to maintain the specified slump during placement.

B. Cold Weather Concreting: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures.

1. Follow ACI 301 and ACI 306.

2. When ambient temperature at site is below 40 degrees F or is expected to fall to that temperature within ensuing 24 hours, heat water and/or aggregate prior to adding to mix so that temperature of concrete will be between 55 degrees F and 85 degrees F at time of placement.

3. Maintain temperature of deposited concrete between 50 degrees F and 70 degrees F for minimum of seven days after placing.

C. Temperature Changes: Maintain changes in concrete temperature as uniformly as possible, but in no case exceed change of 5 degrees F per hour or 25 degrees F in any 24 hour period.

D. Combustion heaters shall not be used during the first 48 hours without precautions to prevent exposure of concrete and workmen to exhaust gasses containing carbon dioxide and/or carbon monoxide.

E. Admixtures intended to accelerate hardening of concrete or produce higher than normal strength at early periods will not be permitted unless approved by the Architect. The use of calcium chloride is specifically prohibited.

1.07 SEQUENCING/SCHEDULING:

A. Coordinate Work of this Section with work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Cement/Fly Ash:

1. Portland Cement, Type I or III, conforming to the requirements of ASTM C150.

2. Fly Ash, Class C or F, conforming to the requirements of ASTM C618. The use of Fly Ash shall be subject to review by the Architect. Where Fly Ash is used in the mix design, Fly Ash shall comprise no more than 20% by weight of the total cementitious material in the mix. Fly Ash shall not be used in floor slab.

B. Aggregate:

1. Fine: ASTM C33; clean, hard, durable, uncoated, natural sand, free of silt, loam or clay.

2. Coarse: ASTM C33; hard, durable, uncoated, gravel gradation in accordance with Size No. 467 for piers and concrete footings and Size No. 67 for all other concrete. Maximum aggregate size in accordance with ACI 318.

3. Coarse aggregate for structural lightweight concrete shall conform to the applicable requirements of ASTM C330 suitably processed, washed and screened, and shall consist of durable particles without adherent coatings. Gradation in accordance with Size Designation 3/4 inch to No.4, Table 1, ASTM C330.

4. Grading shall be in accordance with "Standard Method for Sieve Analysis of Sieve and Coarse Aggregates" (ASTM C136).

C. Water: ASTM C94, Paragraph 4.1.3; potable, clean and free from oil, acid and injurious amount of vegetable matter, alkalies, and other impurities.

D. Admixtures:

1. Cement-dispersing, water-reducing types. Admixtures shall conform to ASTM C494, Type A or D, and shall be used strictly in accordance with manufacturer's recommendations and as determined by the Testing Laboratory. Admixture shall not discolor concrete or in any way affect the appearance of the concrete.

a. High-range water reducing admixture conforming to ASTM C494, Type F, may be used as required and shall be one of the following types or equal:

1. Master Builders Admixture LA-35

2. SIKA Sikament

3. W.R. Grace WRDA-19

2. An air-entraining admixture conforming to ASTM C260 shall be used as required on the Drawings and shall be one of the following types or equal:

a. Master Builders MB-VR

b. SIKA AER

c. W.R. Grace Darex AEA

3. Use of calcium chloride is specifically prohibited.

E Non-Shrink Cement Grout:

1. Qualities: Premixed non-shrink grout requiring only addition of water. Non-metallic type grout where grout will be sight exposed.

a. Minimum compressive strength of 5000 PSI at 7-days and 7500 PSI at 28-days when placed at a plastic consistency of 115% flow factor.

b. Free of chloride, sulphates or gas producing agents.

2. Standards:

a. Overall product: CRD-C-621.

b. Compressive Strength: ASTM C109, 2 inch cubes.

c. Bleed Performance: CRD C-611.

d. Flow Factor: ASTM C230.

F. Miscellaneous Structural Metals Associated with Structural Concrete:

1. All structural steel pieces including miscellaneous structural metals placed in concrete exposed to weather, in permanent contact with soil, or accessible to salt intrusion shall be hot dipped galvanized in accordance with ASTM A123.

2. All structural steel pieces embedded in concrete shall conform to ASTM A36, unless noted otherwise on the Drawings.

3. Welding of inserts, anchors and other steel pieces used in conjunction with structural concrete shall conform to AWS D1.1.

4. Welding of reinforcing steel used in conjunction with structural concrete shall conform to AWS D1.4.

5. Headed stud anchors shall conform to ASTM A108, minimum tensile strength 60,000 PSI.

6. Concrete expansion anchors shall be wedge-type anchors, meeting the requirements of Federal Specification FF-S-325, Group II, Type 4, Class 1, plated in accordance with Federal Specification QQ-Z-325C, Type II, Class 3. Size and location shall be as indicated on the Drawings.

7. Brick Shelf Inserts: Hohmann and Barnard, Inc., type LW-340, hot dipped galvanized with 3/4" diameter stainless steel askew head bolts.

G. Sawcut Joint Sealant - Two component elastomeric sealant.

2.02 CONCRETE MIXES:

A. Strength: Concrete is classified and specified by ultimate compressive strength (f'c) at the age of 28 days.

B. Design concrete to yield strengths indicated on the Drawings.

C. Concrete permanently exposed to weather shall contain an air-entraining admixture to produce an air content in the range of 3% to 5% air by volume of concrete.

D. Proportions: Proportions of cement, aggregate, and water to attain required plasticity and compressive strength shall be in accordance with ACI 318. Do not make changes in proportions without submitting proposed changes to Testing Laboratory for evaluation.

1. Trial mixtures having proportions and consistencies suitable for the work shall be made based on ACI 211.1, using at least three different water-cement ratios which will produce a range of strengths encompassing those required for this project.

2. Trial mixes shall be designed to produce a slump within 3/4" of the maximum permitted, and for air-entrained concrete, within 0.5 percent of maximum allowable air content. The temperature of concrete used in trial batches shall not exceed the maximum temperature specified.

3. For each water-cement ratio, at least three confirmation compression test cylinders for each test age shall be made and cured in accordance with ASTM C192. Confirmation cylinders shall be tested at seven and twenty-eight days in accordance with ASTM C39.

4. From the results of the twenty-eight day confirmation test, a curve shall be plotted showing the relationship between the water-cement ratio and compressive strengths. From this curve, the water-cement ratio to be used in the concrete shall be selected to produce the average strength required.

5. The cement content and mixture proportions to be used shall be such that this water-cement ratio is not exceeded when slump is the maximum permitted. Control in the field shall be based upon maintenance of proper cement content, slump and air content.

6. Mix designs furnished by the concrete supplier, and accompanied by test data showing an acceptable strength history meeting the requirements of Method 2 as specified in section 3.8 of ACI 301, will be considered an acceptable alternative to the procedure described in paragraphs above.

   a. Temperature of concrete in test data shall be within 5 degrees F of maximum temperature specified for this project.

   b. Strengths indicated in test data shall be in accordance with ACI 318, paragraph 4.3.

   c. The specified strength of concrete used in supporting test data shall vary no more than 500 PSI plus or minus from that specified for this project.

7. The Testing Laboratory shall keep a strength history record of all concrete for the duration of the project as specified in this section.

PART 3 - EXECUTION

3.01 GENERAL:

A. Inserts: Give the various trades and subcontractors ample notification and opportunity to furnish any and all anchors, nailers, pipes, conduits, boxes, inserts, thimbles, sleeves, frame vents, wires, supports, or other items required to be built into the concrete by the provisions of the Drawings or of the Specification governing the work of such trades and subcontractors, or as it may be necessary for the proper execution of their work. Obtain suitable templates or instructions for the installation of such items which are required to be placed in the forms.

B. Slump:

1. Concrete not containing a high range water reducing admixture shall not be placed when its plasticity, as measured by slump test, is outside the following limits:

Unit	Slump
Piers, footings	6" max., 4" min.
All other Concrete	5" max., 3" min.

2. Concrete containing a high range water reducing admixture shall not be placed when its plasticity, as measured by slump test, is outside the following limits:

   a. Prior to addition high range water reducer: 3 inch maximum, 1 inch minimum.

   b. After addition of high range water reducer: 10 inch maximum.

C. Classes of Concrete and Usage: Concrete of the several classes of concrete required shall have the characteristics shown on the Drawings.

D. Mixing:

1. Transit-mixed concrete conforming to the requirements of ASTM C94 and ACI 304 shall be used in lieu of concrete mixed at the job site. Concrete shall not be transported or used in any case after a period in excess of ninety (90)minutes has elapsed after the introduction of water into the mixer.

2. Indiscriminate addition of water to increase slump of concrete is prohibited. Add water only at the direction of the Testing Laboratory. No water shall be added which increases the water cement ratio of the concrete in excess of the water cement ratio indicated on the approved mix design. At the direction of the Testing Laboratory the addition of a high range water reducing admixture may be used to re-temper concrete.

3. The agency supplying transit-mixed concrete shall have a plant of sufficient capacity and adequate transportation facilities, to assure continuous delivery at the rate required. The frequency of deliveries to the site of the work must be such as to provide for placing the concrete continuously throughout any one (1) pour.

E. Conveying Concrete: Convey concrete from the mixer to the place of final deposit by methods which will prevent the separation or loss of the ingredients. Concrete to be conveyed by pumping shall be submitted to the Testing Laboratory for evaluation for each class of concrete shall be taken at the discharge end of the pumping equipment.

F. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to assure a practically continuous flow of concrete at the delivery end without separation of the materials. The use of gravity-flow or aluminum chutes or conveyors for transporting concrete horizontally will not be permitted.

3.02 PLACING CONCRETE:

A. Place concrete in reasonably uniform layer, approximately horizontal, and not more than eighteen inches (18") deep, exercising care to avoid vertical joints or inclined planes. The piling up of concrete in the forms in such a manner as to cause the separation or loss of any of its ingredients will not be permitted. Concrete which has partially set or hardened shall not, under any circumstances, be deposited in the work.

B. Place concrete in the forms as nearly in its final position as is practical to avoid rehandling. Exercise special care to prevent splashing the forms or reinforcement with concrete. Remove any hardened or partially hardened concrete which has accumulated on the forms or reinforcement before the work proceeds. Do not place concrete on previously deposited concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the respective member of section, except as hereinafter specified.

C. Do not permit concrete to drop freely any distance greater than five feet (5'). Where longer drops are necessary, use a chute, tremie, or other acceptable conveyance to assist the concrete into place without separation. Do not pour directly into any excavations where water is standing.

D. Vibration: As soon as concrete is deposited, thoroughly agitate same by means of mechanical vibrators and suitable hand tools, so manipulated as to work the mixture well into all parts and corners of the forms, and entirely around the reinforcement and inserts. Mechanical vibrators shall maintain frequencies in accordance with the recommendations of ACI 309. Table 5.1.4, and shall be operated by competent workmen. Over vibrating and use of vibrators to transport concrete within forms shall not be allowed. A spare vibrator shall be kept on the job site during all concrete placing operations.

E. Bonding: Before depositing any new concrete on or against previously deposited concrete which has partially or entirely set, the surface of the latter shall be thoroughly roughened and cleaned of all foreign matter, scum and laitance.

F. Construction Joints: Except as otherwise specifically indicated on the Drawings, each concrete member shall be considered as a single unit of operation, and all concrete for the same shall be placed continuously in order that such unit will be monolithic in construction. Should construction joints prove to be absolutely unavoidable, same shall be located at or near the midpoints of spans. Additional construction joints shall not be made under any circumstances without prior review by the Architect.

G. Protect all freshly placed concrete from washing by rain, flowing water, etc. Do not allow the concrete to dry out from the time it is deposited in the forms until the expiration of the curing period.

H. Refer to structural drawings for column base plate and other structural grouting requirements.

I. Grout shall be mixed only in such quantities as are needed for immediate use. No re-tempering shall be permitted and materials which have been mixed for a period exceeding thirty (30) minutes shall in no case be used upon any portion of the work.

J. Imperfect or damaged work, or any material damaged or determined to be defective before final completion and acceptance of the entire job, shall be satisfactorily replaced at the Contractor's expense and shall be in conformity with all of the requirements of the Contract Documents. Removal and replacement of concrete work shall be done in such a manner as not to impair the appearance or strength of the structure in any way.

K. Cleaning: Upon completion of the work, all forms, equipment, protective coverings and any rubbish resulting therefrom shall be removed from the premises. Finished concrete surfaces shall be left in clean and perfect condition, satisfactory to the Owner. Sweep with an ordinary broom and remove all mortar, concrete droppings, loose dirt, mud, etc.

3.03 FIELD QUALITY CONTROL AND TESTING:

A. Secure composite samples in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement.

B. All concrete shall be tested as follows:

1. Mold and cure five (5) specimens from each sample in accordance with ASTM C31.

2. Two (2) specimens shall be tested at seven days for information, two shall be tested at 28 day for acceptance, and the remaining cylinder shall be tested as directed.

C. Specimens for pumped concrete shall be taken at the discharge end of pumping equipment.

D. Any deviations from the requirements of ASTM Specifications shall be recorded in the test report. Test concrete specimens in accordance with ASTM C39.

E. Make at least one strength test (five specimens) for each 100 cu. yd. or fraction thereof, of each mix design of concrete placed in any one day. Determine slump of the concrete sample for each strength test and whenever consistency of concrete appears to vary, in accordance with ASTM C143.

F. Determine air content of air-entrained, normal weight and/or lightweight, concrete sample for each strength test, in accordance with either ASTM C231 or ASTM C173. Determine the unit weight of the concrete sample for each strength test in accordance with ASTM C138. Determine temperature of concrete sample for each strength test.

G. Inspect each batch of concrete, monitor addition of mixing water to assure uniform consistency from truck to truck. Check mixing from mixers before mix begins to set and within time limits set forth in ASTM C94.

1. Monitor addition of water to concrete at job site and length of time concrete is allowed to remain in truck during placement.

2. Certify each delivery ticket indicating class of concrete delivered, amount of water added and time at which cement and aggregate was discharged into truck, and time at which concrete was discharged from truck.

H. Should the strength of concrete fall below the minimum, then additional tests, including load tests, may be required. These tests, if required, shall be made at the Contractor's expense and shall be in accordance with ASTM C42 and ACI 318. If tests do not meet the applicable requirements, then the structure, or any part of the structure, shall be removed and replaced at the Contractor's expense.

I. Test reports shall include but not be limited to the following information: Date of concrete placement, concrete mix identification number or proportions of ingredients, truck ticket number, time test was made, time of batching, location of each placement, slump, unit weight and air content of concrete sampled and date and results of strength test.

J. Report promptly to Architect all details of reasons for rejection of any and all quantities of concrete. Give all information concerning locations of the concrete pours, quantities, date of pours, and other pertinent facts concerning concrete represented by the specimens.

K. Any concrete testing requested by the Contractor for early formwork or shoring removal, etc., shall be at the Contractor's expense.

L. Furnish a statistical analysis for each class of concrete placed on the project in accordance with ACI 214-77 and ACI 318. Information shall be updated and distributed once a month as directed by the Architect. Information shall include, but not be limited to, the following:

Strength tests at 7 days of 2 cylinder averages.

Strength tests at 28 days of 2 cylinder averages.

28-day moving average strength tests of last 3 test groups.

Standard deviation and coefficient of variation based on 28 day strength tests.

Average strength and number of 28 day tests for most recent month.

3.04 GROUT:

A. For every one-third (1/3) cubic yards of grout placed, grout strength shall be tested with a set of cubes as follows:

B. A set of cubes shall consist of three cubes to be tested at 7 days, and three cubes to be tested at 28 days.

C. Test cubes shall be made and tested in accordance with ASTM C109, with the exception that the grout should be restrained from expansion by a top plate.

END OF SECTION

SECTION 03345 - CONCRETE FINISHING

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Perform all work required to complete the Concrete Finishing indicated by the Contract Documents and furnish all supplementary items necessary for its proper execution.

1.02 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 1 specification sections, apply to work of this section.

1.03 CODES AND STANDARDS:

A. Work described in this Section, unless otherwise noted on the Drawings, or herein specified, shall be governed by the latest editions of the following codes or specifications.

1. ACI 301, "Specifications for Structural Concrete for Buildings".

2. ACI 305, "Hot Weather Concreting".

3. ACI 306, "Cold Weather Concreting".

4. ACI 311, "ACI Manual of Concrete Inspection".

5. ACI 318, "Building Code Requirements for Reinforced Concrete".

6. ASTM C309, Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.

1.04 PROJECT DATA:

A. Submit copies of manufacturer's literature for all products.

1.05 FINISHING TOLERANCES:

A. Tolerances:

1. Construct formwork to provide concrete surfaces conforming to tolerances of Section 3.3, ACI 347.

2. Establish and maintain, in an undisturbed condition and until final completion of project, sufficient control points and bench marks to be used for reference purposed to check tolerances.

3. Regardless of tolerances specified herein, no portion of building shall extend beyond legal boundary of project.

4. Floor Finished Surface Flatness and Levelness (random traffic areas):

a. Floor slabs shall conform to the following ACI F-number requirements:

Slab on grade: Specified Overall Value: Ff35/fl24
Minimum Local Value: Ff15/Fl10

PROVIDE ALTERNATE FOR VERY FLAT FLOOR

Slab on grade: Specified Overall Value: Ff50/fl35
Minimum Local Value: Ff25/Fl15

b. Shall be tested in accordance with the requirements of ASTM E1155, the following percentages of elevation samples on a Test Surface shall fall within a level 3/4" envelope. Percentages apply to the entire Test Surface.

Slab on grade: 90%

The arithmetic mean of these elevation samples shall not deviate from design grade more than the following amounts:

Slab on grade: 0.25"

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Liquid Membrane-Forming Curing Compound: Liquid type water based membrane-forming dissipating curing compound complying with ASTM C 309.

1. "1100 - Clear"; W.R. MEADOWS. Curing Compound must be compatible with floor sealer.

B. Metallic Floor Hardener: Dry Shake Heavy Duty Metallic Floor Hardener.

1. “Diamond-Plate”, Euclid Chemical or equivalent.

PART 3 - EXECUTION

3.01 FORMED SURFACES:

A. As-Cast Rough Form Finish: Rough or board form finish surfaces shall be reasonable true to line and plane with no specific requirements for selected facing materials. Defects shall be patched and fins exceeding 1/4" in height shall be rubbed down with wooden blocks. Otherwise, surfaces shall be left with the texture imparted by the forms.

B. As-Cast Smooth Form Finish: Form facing materials shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, tempered concrete-form-grade hardboard, metal, plastic, paper or other material capable of producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn edges, patches, dents or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All fins shall be completely removed.

3.02 REPAIR OF DEFECTIVE AREAS:

A. All honeycombed and other defective concrete shall be removed down to sound concrete. If chipping is necessary the edges shall be perpendicular to the surface or slightly undercut. No feather edges will be permitted.

B. The area to be patched and an area at least 6 inches wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared, using a mix of approximately one part cement to one part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surface.

C. The patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the course aggregate shall be omitted and the mortar shall consist of not more than one part cement to 2 1/2 parts sand by damp loose volume.

D. White Portland Cement shall be substituted for a part of the gray Portland Cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing.

E. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

F. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface.

G. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.

H. All high points on the building slab that do not meet the require tolerance will be ground down to tolerance.

3.03 SLAB SURFACES:

A. Troweled Finish:

1. The surface shall be finished first with impact power floats, then with power trowels. The first troweling after power floating shall be done by a power trowel and shall produce a smooth surface which is relatively free of defects but which may still contain some trowel marks.

2. Additional trowelings shall be done by power trowel after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the final troweling operations.

3. The finished surface shall be free of any trowel marks and shall be uniform in texture and appearance and shall be plane to a required tolerance. High points of the finished slab, which do not meet tolerance requirements shall be removed by grinding.

4. Slab shall be cured for a minium of seven (7) days with a spray on concrete curing compound. Curing compound shall be applied per manufacturers recommendations.

5. Slab shall be fee of holes, nails, embeds or other objectionable items at completion of construction.

3.04 SCHEDULE OF FINISHES:

A. As-Cast Rough Form Finish: All concrete surfaces below grade.

B. As-Cast Smooth Form Finish: All interior and exterior concrete surfaces exposed to view.

C. Troweled Finish: Floor surfaces scheduled as exposed or to receive floor covering.

D. Broom Finish: Exterior horizontal surfaces not scheduled for nonslip finish and interior surfaces scheduled to receive thin set tile.

END OF SECTION

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Includes furnishing all materials, equipment and services as required in conjunction with or properly incidental to construction of all masonry as described and/or as shown on the Drawings.

B. Comply with Drawings and general Requirements and Referenced Documents.

1.02 CODES AND STANDARDS:

A. Concrete masonry unit manufacturer shall certify that masonry units furnished meet or exceed requirements of this Specification.

B. The work in this Section, unless noted on the Drawings, or herein specified shall be governed by the latest edition of the following codes or specifications.

1. ACI 531 "Building Code Requirements for Concrete Masonry Structures."

2. ASTM C-145 "Standard Specification for Solid Load Bearing Concrete Masonry Units."

3. ASTM C-270 "Standard Specification for Mortar for Unit Masonry."

1.03 SUBMITTALS:

A. Submit shop drawings showing dimensions necessary for fabrication and placement of reinforcement and accessories.

B. Do not make shop drawings using reproductions of Contract Drawings.

C. Submit in writing any requests for modification to Drawings or Specifications. Submitting shop drawings for review does not constitute "in writing" unless it is brought to the attention of the Architect that specific changes are being suggested.

1.04 STORAGE OF MATERIALS:

A. Deliver materials to job site in undamaged condition.

B. Store concrete masonry units on raised platforms. Cover and protect units from inclement weather.

C. Store mortar and grout materials in manner to prevent intrusion of moisture and contaminants.

1.05 JOB CONDITIONS:

A. Masonry construction shall be in compliance with "Recommended Practices and Specifications for Cold weather Masonry Construction" adopted February 1975 by International Masonry Industry All-Weather Council and as specified herein.

B. Lay no concrete masonry unit when air temperature is below 40 degrees F unless materials are protected from weather and laid up in shelter. In such instances, maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

C. In temperatures exceeding 100 degrees F, do not lay out mortar beds ahead of placing units. Use a very light fog spray, not sufficient to penetrate masonry, on vertical surface of masonry to aid in mortar curing during first 24 hours after placing units.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Concrete Block:

1. Hollow load-bearing units:

   a. ASTM C 90, Grade N general purpose, Type I moisture-controlled. Units shall have a compressive strength of 2,000 psi on net area.

   b. Nominal face dimensions: 8" high x 16" long.

   c. Provide standard and fire rated units.

2. Provide normal weight aggregate units.

3. Masonry Units shall be manufactured by Feather Lite Building Products, P.O. Box 1029, Austin, Texas 78767, 512/472-2424.

4. Special shapes:

   a. 8" Smooth and Split Face Block Hollow Core Units.

B. Flashing:

1. 20-mil minimum thickness elastomeric impermeable sheet material.

2. Resistant to corrosive effects of masonry mortar.

3. Acceptable product: Nervastral HD, Rubber and Plastics Compound Co., Inc.

C. Horizontal Joint Reinforcing:

1. Continuous open-web welded wire trusses, 9 ga. side rods and diagonal ties, galvanized finish, welded at 16" intervals to continuous side rods forming truss design.

2. Prefabricated corner and "tee" intersecting units.

3. Size for single wythe construction.

4. Acceptable products:

a. Dur-O-Wal, Dur-O-Wal Company.

b. Blok-Trus, AA Wire Products Company.

c. Trus-Mesh, Hohmann and Barnard.

D. Reinforcing Rods: ASTM A 615, Grade 60.

E. Weeps: PVC plastic tubes or sash cord.

F. Portland Cement:

1. ASTM C 150, Type I or Type III, nonstaining.

2. Use of masonry cement will not be permitted.

G. Hydrated Lime: ASTM C 207, Type S.

H. Mortar Aggregates:

1. ASTM C 144, free of clay or organic matter.

2. Gradation:

Sieve Size	Percent Passing
No. 4	100
No. 8	95 to 100
No. 16	60 to 100
No. 30	35 to 70
No. 50	15 to 35
No. 100	2 to 15
No. 200	0 to 2

I. Portland Cement Grout Aggregates: ASTM C 33, pea gravel uniformly graded from 3/8" to 1/2".

J. Water: Clean and free of deleterious amounts of acids, alkalies or organic matter.

K. Cleaning Agents:

1. Combination of surface acting acids and wetting agent for general purpose cleaning of new masonry surfaces.

2. Acceptable product: Sure-Klean No. 600 Detergent, Pro/So/Co., Inc.

2.02 MIXES:

A. Mortar Proportions:
1. Nonload-bearing walls: ASTM C 270, Type N, 750 psi at 28 days, (1:1:6).

2. Load-bearing walls: ASTM C 270, Type S, 1800 psi at 28 days, (1:1/2:4-1/2).

B. Portland Cement Grout: Portland cement, sand, pea gravel and water proportioned to produce 2,500 psi at 28 days with 9-1/2" slump when placed.

C. Control batching procedure to ensure proper proportions by measuring materials by volume. Measurement by shovel will not be permitted.

D. Mix mortar in accordance with requirements of BIA M 1 and grout in accordance with ASTM C 476.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Inspect foundation to assure surfaces to support masonry are to proper grade and elevation and free from dirt or other deleterious matter.

3.02 PREPARATION:

A. Concrete Masonry Units:

1. Lay only dry units, free of paint, oil, efflorescence or foreign matter.

2. Remove laitance, loose aggregate or anything that prevents bonding to foundation.

B. Reinforcement: Before being placed, remove loose coatings from reinforcement.

C. Use masonry saws to cut masonry units.

3.03 INSTALLATION:

A. Installation Tolerances:

1. Maximum Variation from Plumb:

a. Vertical lines and surfaces of columns and walls:

(1) 1/4" in 10'-0".

(2) 3/8" in 20'-0" maximum.

(3) 1/2" in maximum.

b. External corners or control joints:

(1) 1/4" in 20'-0".

(2) 1/2" in 40'-0" maximum.

2. Maximum Variation from Level or Grades for Exposed Lintels, Sill, Parapets or Horizontal Grooves:

   a. 1/4" on any bay or 20'-0".

   b. 1/2" in 40'-0".

3. Maximum Variation from Plan Location of Linear Building Line or Related Portions of Columns, Walls and Partitions:

   a. 1/2" in any bay or 20'-0".

   b. 3/4" in 40'-0".

4. Maximum Variation in Cross-Sectional Dimensions of Columns and Thickness of Walls:

   a. -1/4"; +1/2".

B. Pattern Bond: Running bond with vertical joints located at centerline of masonry units in alternate courses unless noted otherwise on architectural drawings.

C. General:

1. Set units plumb, true to lien and with level courses accurately spaced within allowable tolerances.

2. Do not install cracked, broken or chipped masonry units exceeding ASTM allowables.

3. Adjust masonry unit to final position while mortar is soft and plastic.

4. Where adjustment must be made or if units are displaced after mortar has stiffened, remove units, clean joints and units of mortar and relay with fresh mortar.

5. Do not pound corners and jambs to fit stretcher units after they are set in position.

6. Adjust shelf angles to keep masonry level and at proper elevation.

7. Provide pressure relieving joints by placing continuous 1/8" foam pad under shelf angle.

D. Mortar Beds:

1. Hollow units:

   a. Lay with full mortar coverage on horizontal and vertical face shells.

   b. Provide full mortar coverage on horizontal and vertical face shells and webs where adjacent to cells or cavities to be filled with grout.

E. Horizontal and Vertical Face Joints:

1. Construct uniform joints, 3/8" nominal thickness.

2. Shove vertical joints tight.

3. Tool concave joints in exposed surfaces when thumb-print hard with round joints slightly larger than width of joint.

4. Flush cut all joints not exposed.

5. Fill horizontal joints between top of non-load bearing masonry partitions and underside of beams or slabs with flexible material.

F. Control Joints:

1. Keep clean of mortar and debris.

2. Install where indicated and at following locations:

a. Changes in thickness, height and direction.

b. Within 8'-0" of corners or offsets.

c. At control or expansion joints in structure.

d. At each side of openings greater than 24" wide.

e. Place control joints at foundation walls, shelf angles, setbacks and materials expanding at different ratios.

3. Concrete masonry units:

a. Space joints at 30'-0" o.c. maximum in uninterrupted walls.

b. Provide continuous vertical control joints through bond beams except at lintels above openings.

c. Offset control joints to ends of lintels.

G. Collar Joints:

1. Keep cavity in cavity walls clean.

2. Remove all protruding mortar fins in cavity to be grouted.

H. Joining of Work:

1. When joining fresh masonry to set or partially set masonry construction, remove loose units and mortar and clean exposed surface of set masonry prior to laying fresh masonry.

2. If necessary to stop off horizontal run of masonry, rack back one-half block length in each course.

3. Do not use toothing to join new masonry to set or partially set masonry.

I. Reinforcing and Ties:

1. Bars:

a. Reinforce each jamb of wall openings with one bar vertical.

b. Place reinforcing bars in hollow cores vertically where indicated.

2. Horizontal joint reinforcing:

a. Fully embed joint truss type reinforcement in each alternate bed joint 16" o.c.

b. Extend joint reinforcement entire length of bed joint.

c. Place reinforcing in course immediately above opening extending at least 16" past each side of opening.

d. Lap reinforcement minimum 6" at ends.

e. Bend or weld at offsets or special conditions.

J. Bond Beams:

1. Provide CMU bond beams at top of CMU walls and lintels above openings.

2. Reinforce bond beams with minimum of two bars and grout.

3. Discontinue bond beams at expansion and control joints.

K. Flashing:

1. General:

a. Clean surface to receive flashing and remove projections which might puncture or damage flashing material.

b. Seal joints with manufacturer's recommended adhesive.

c. Seal top of flashing to ensure moisture cannot infiltrate behind flashing.

d. Continue flashing around corners. Ensure membrane material is not interrupted in horizontal plane at corners.

2. Wall base, opening sills and heads:

a. Place flashing on mortar bed and cover with mortar.

b. Start 1/2" from outside face of wall and turn up in cavity 8" minimum.

c. Lap joints 4" minimum.

d. Place flashing under and behind sills.

e. Place flashing over steel lintels.

f. Extend flashing beyond opening jamb lines.

L. Weep Holes:

1. Provide weep holes in head joints in first course immediately above flashing by either leaving head joint free and clean of mortar or placing and leaving sash cord or plastic weeps in joint.

2. 24" o.c. maximum spacing.

3. Keep weep holes and area above flashing free of mortar waste.

M. Built-In Work:

1. At completion of conventional masonry unit work, fill holes in joints and tool.

2. Cut out and re-point defective joints.

3. Dry brush masonry surface after mortar has set at end of each day's work and after final pointing.

3.04 CLEANING:

A. Clean initially with stiff brushes and water. Remove efflorescence in accordance with manufacturer's recommendations.

B. When cleaning agent is required, apply cleaning agent to sample wall area of 20 sq. ft.

1. Do not proceed with cleaning until sample area is reviewed.

2. Scrub with acceptable cleaning agent and immediately rinse with clear water.

3. Do small sections at a time, working from top to bottom.

4. Protect sash, metal lintels and other corrosive parts when masonry is cleaned with acid solution.

C. Leave area and surfaces clean and free of mortar spots, drippings and broken masonry.

END OF SECTION

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Provide all items of structural steel as described herein and as shown and/or noted on the Drawings.

1.02 CODES AND STANDARDS:

A. The work described in this section, unless otherwise noted on the Drawings or herein specified, shall be governed by latest editions of the following Codes or Specifications:

1. "Code of Standard Practice for Steel Buildings and Bridges", AISC, including commentary, latest edition.

2. "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" - AISC, including commentary, latest edition.

3. "General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and bars for Structural Use" - ASTM A6.

4. Applicable Material Specification - ASTM.

5. "Structural Welding Code" - AWS D1.1.

6. "Specification for Structural Joints Using ASTM A325 or A490 Bolts" - As approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation, latest approved edition.

1.03 SUBMITTALS:

A. Product Data: Submit producer's or manufacturer's specifications installation instructions for the following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

1. Structural steel (each type), including certified copies of all mill reports covering chemical and physical properties.

2. High-strength bolts (each type), including nuts and washer.

3. Structural steel primer paint.

4. Non-shrink grout.

B. Shop Drawings:

1. Submit shop drawings prepared under the supervision of a registered Professional Engineer licensed in the State in which the project is located in accordance with Specifications.

2. Show complete details and schedules for the fabrication and shop assembly of members. Detail to conform to AISC "Structural Steel Detailing". Clearing indicate profiles, sizes, spacing and locations of structural members, connections, attachments, anchorages, framed openings, size and type of fasteners and cambers. Show AWS weld types.

3. Shop drawings shall include erections sequences, procedures and diagrams, schedules, and complete details. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others. Any fabrication of material before review of shop drawings shall be at the risk of the Contractor.

4. The Contractor shall completely outline a proposed method and sequence of erection to the Architect for review before delivering any material to the job site. The outline shall be prepared to avoid delay or any damage to the work of other trades.

C. Welder's Certificates: Submit Welder's Certifications performed by a qualified testing laboratory in accordance with AWS D1.1, "Standard Qualification Procedure".

D. Test Reports: The Testing Laboratory shall submit copies of reports of shop and field inspections and test performed in accordance with Specifications.

1.04 FITTING OF STRUCTURAL MEMBERS:

A. The Contractor alone shall be responsible for the correct fitting of all structural members and for the elevation and alignment of the finished structure.

1.05 ADJUSTMENTS:

A. Any adjustments necessary in the steel frame because of fabrication, construction or erection discrepancies in elevations and alignment shall be the responsibility of the Contractor. Any modification to the approved manufactured material shall be approved by the Architect and Structural Engineer.

1.06 PROPOSED SUBSTITUTIONS:

A. Substitutions of sections or modifications of details, if proposed by the Contractor, shall be submitted for review in sketch form prior to submission of shop drawings.

1.07 STORAGE OF MATERIALS:

A. Storage of fabricated steel at the job site shall be the responsibility of the Contractor. Material stored at the job site shall be placed so that design loads on existing or newly-constructed structures are not exceeded and members will not be distorted or otherwise damaged. All materials shall be protected against corrosion or deterioration of any kind.

B. The Architect/Engineer will reject any material that has become damaged because of improper storage.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. All materials shall be of new manufacture and shall conform to the respective specifications (latest revision) and other requirements specified below .

1. Steel: ASTM A36, A36/572 or A992 as indicated. New manufacture, free from defects which would impair strength, durability, appearance or function.

2. Steel Pipe: ASTM A53, Type "E" or "S", or ASTM A501.

3. Steel Tube: ASTM A500, Grade B, 46 KSI.

4. Bolts: Anchor bolts and erection bolts not specified as high strength shall meet requirements of ASTM A307, Grade A.

a. High Strength bolts shall meet ASTM A325.

b. Nuts: ASTM A563 and ANSI B18.2.2.

c. Washers: ASTM F436.

d. Direct tension indicator bolts or load indicator washers conforming to AISC Specifications for Structural Joints.

1. Load Indicator Bolts - Bethlehem Steel.

2. Tension Control - Le Jeune.

3. Coronet Load Indicator - Cooper & Turner, Inc.

4. Load Indicator Washers - Bethlehem Steel.

5. Welding Electrodes: AWS A5.1 or A5.5 for Series #E70 electrodes.

6. Headed Stud Anchors: ASTM A108, minimum tensile strength 60,000 PSI.

7. Galvanizing: All items of structural steel noted to be galvanized shall conform to ASTM A123 (latest edition). All anchors, bolts, washers, etc. in conjunction with galvanized surfaces shall also be galvanized to conform to these requirements.

8. Grout: Refer to Section 03300 for nonshrink grout.

9. Primer/Paint: Shop applied primer and field touch-up shall be grey primer. Application standards shall meet or exceed requirements of Federal Specification TT-P-86G, Types I and III.

10. Miscellaneous Materials and Accessories: As specified hereinafter under the various items of work and/or as indicated on the Drawings or as required for good construction practice.

2.02 FABRICATION:

A. General:

1. All work shall be shop assembled insofar as possible and delivered to the site complete and ready for erection. Material shall be properly marked and match-marked where field assembly is required. The sequence of shipments shall be such as to expedite erection and minimize field handling of material.

2. Steel members shall be cambered if so indicated on the Drawings.

3. Steel members without specified camber shall be fabricated so that after erection, any minor camber due to rolling or fabrication shall be upward.

B. Connections:

1. Connections not detailed on the Drawings shall be selected from Part 4 of the Manual of Steel Construction of the AISC.

2. Shop and field connections shall be bolted or welded as detailed.

3. No combination of bolts and welds shall be used for stress transmission in the same face of any connection.

C. Shop Welding:

1. All welding shall be done in accordance with AWS D1.1.

2. Intermittent and continuous welding shall be done in a manner to minimize internal stresses.

3. Welds not specified shall be continuous fillet welds, sufficient to transmit required forces, using minimum fillet as specified by AWS D1.1.

D. Openings for other work: Provide openings in structural members only as shown on the structural drawings, or as directed by the Architects.

E. Shop Painting:

1. Shop paint structural steel work, except those members or portions of members to be embedded in concrete or mortar, or contact surfaces which are to be welded or high-strength bolted. Paint embedded steel on exposed portions and initial 2" of embedded areas only.

2. Surface Preparation: Clean steel work to be painted complying with SSPC (Steel Structures Painting Council) SP-3 "Power Tool Cleaning". Remove oil, grease and similar contaminants, complying with SSPC SP-1 "Solvent Cleaning".

3. Application: Immediately after surface preparation, apply one coat of structural steel primer paint according to manufacturer's instructions to provide a uniform dry film thickness of 2.5 mils. Provide full covering on joints, corners, edges and all exposed surfaces.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Templates shall be securely in place to preclude misplacement of anchor bolts, and the bolts shall be installed at locations and with projections established on final structural steel shop drawings. Check correct positioning before concrete is placed.

3.02 ERECTION:

A. Tolerances: Unless otherwise noted, individual members of the structure shall be leveled and plumbed to an accuracy of 1 to 500, but not to exceed two inches (2") in columns for their full height.

B. Temporary Connections: Shall be designed to adequately resist all gravity and lateral loads, and erection stresses. The method of temporary connections shall be shown on the shop drawings.

C. Field Bolting: Drift pins shall not be used to enlarge unfair holes in main materials. Burning and drifting may be used to align unfair holes in secondary bracing members only after evaluation by the Architect.

D. Grouting of Base Plates and Bearing Plates: Plates shall be set and anchored to the proper line and elevation. Metal wedges, shims, and/or setting nuts shall be used for leveling and plumbing of structural members, including columns. Concrete surfaces shall be rough, free of oil, grease, and laitance, and shall be damp. Surfaces shall be clean and free of oil, grease and rust. The addition of water, mixing and placing shall be in conformance with the material manufacturer's instructions. Grout shall be mixed by using a mortar mixer. Batches shall be of size to allow continuous placement of freshly mixed grout. Placing shall be quick and continuous. Exposed surfaces shall have smooth, dense finish.

E. Headed Stud Anchor Welding: All members or items to which studs are to be attached must be free of all foreign material, such as rust, oil, grease, paint, etc. When the mill scale is sufficiently thick to cause difficulty in obtaining proper welds it must be removed by grinding or sandblasting. Ceramic ferrules used in the stud welding process shall be completely removed.

3.03 PAINTING:

A. Fabrication Painting: Reference paragraph 2.02 E.

B. Powerwash all exposed steel.

C. Field Touch-up Painting: Prepare and coat welds, fasteners, burned and abraded areas as noted under Fabrication Painting.

3.04 FIELD QUALITY CONTROL:

A. Contractor shall provide the Testing Laboratory with names of welder to be employed on work, during fabrication and erection, together with certification that each of these welders has passed qualifications tests within the last year, unless noted otherwise, in accordance with AWS Standards. Welding shall be in accordance with UBC Standards.

B. Inspect all structural steel during and after erection for conformance with Contract Documents and shop drawings. Any cases of insufficient bracing or guying, or other unsafe conditions shall be immediately called to attention of Contractor and reported to Architect.

1. No burning or other field correction of steel members are permitted without express permission of Owner's representative. Immediately report violations.

2. Field Inspection:

a. Obtain planned erection procedure, and review with erector's supervisory personnel.

b. Check installation of anchor bolts and base plates.

c. Verify field welding procedures and welder qualifications to assure conformance with the Specifications.

d. Check steel as received in field for possible shipping damage, workmanship and piece marking.

e. Check plumbness, alignment and chamber as erection progresses including proper bracing.

f. Check joint preparation, fit-up, backing strips and runout plates.

g. Check preheating to assure proper temperature, uniformity, and thoroughness through the full material thickness.

h. Review welding sequence.

i. Visually inspect field welding for size, length, and quality.

END OF SECTION

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Perform all work required to complete the steel joist and joist girder work indicated by the Contract Documents and furnish all supplementary items necessary for its proper installation.

1.02 RELATED DOCUMENTS:

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

1.03 REFERENCE STANDARDS:

A. The term "Standard Specifications" as used shall refer to "Standard Specifications For Open Web Steel Joists, K-Series, and "Standard Specification For Longspan Steel Joists LH Series and Deep Longspan Steel Joists DHL Series", as adopted by the Steel Joist Institute (SJI) and American Institute of Steel Construction (AISC), latest editions.

B. Manufacturer shall be a current member of the Steel Joist Institute.

1.04 SUBMITTALS:

A. Furnish detailed drawings and lists showing the mark, number, type, location and spacings of all joists. Show bridging type, mark, method of attachment to the joists and anchorage at the ends. Show type of paint and all accessories and details as may be required for proper installation of joists.

B. Submit certificate with shop drawings stating joists are manufactured by a member of the Steel Joist Institute and conform to the requirements of the Steel Joist Institute Standard Specifications. Submit certified copies of mill test reports covering chemical and physical properties of steel used in work.

PART 2 - PRODUCTS

2.01 JOISTS:

A. All materials shall be of domestic manufacture and shall conform to the following requirements:

1. Steel Joists and Joist Girders: As required by the Steel Joist Institute.

2. Steel: (Steel bearing plates, bridging, wall anchors, etc.) ASTM A36.

3. Bolts: ASTM A307.

4. Welding Electrodes: AWS A5.1, E60XX or E70XX per Steel Joist Institute Specifications.

5. Paint: Conform to the requirements of Steel Structures Painting Council Specification, SSPC No. 15. Provide Manufacturer's Standard Grey Primer.

2.02 EXTENDED ENDS:

A. To have a load carrying capacity at least equal to the loads shown on the Drawings.

2.03 BRIDGING:

A. Member sizes and end anchorage in accordance with the Standard Specifications unless otherwise indicated on the Drawings. Use horizontal and diagonal bridging as indicated on the Drawings.

PART 3 - EXECUTION

3.01 FABRICATION:

A. General: Contractor alone shall be responsible for errors in fabrication and for correct fitting of joists. Holes shall not be made or enlarged by burning in the shop or field.

B. Joists: Join members by welding in a manner that will produce finished connection of strength required.

C. Accessories: Provide all necessary sag rods, bridging, extended ends, side wall and beam anchors, wall connectors, headers and ceiling extensions.

D. Painting: Scale, rust or other deleterious materials shall be removed from fabricated joists, bridging, anchors, etc., by SJI approved methods before shop coat of paint is applied. Remove grease or oil with Benzine or similar volatile cleaner. After cleaning joists, bridging, etc., give one (1) dip or airless pressure coat of specified paint.

3.02 ERECTION:

A. General: Exercise care in handling and placing joists. Set joists to lines, levels and spacing as indicated. Execute general handling and erection in accordance with SJI Specifications. Minimum bearings and anchorage shall conform to SJI Specifications and/or Drawings. Permanently fasten joists to supports and completely install all bridging and anchors before any construction loads, other than workmen, are placed on joists.

B. Bridging: Conform to requirements of Steel Joist Institute Standard Specifications and as shown on the Drawings. Anchor each line of bridging to walls or supports at ends of line and to each joist by welding or bolting.

C. Welding: Execute welding in accordance with "Code for Arc and Gas Welding in Building Construction" of American Welding Society as amended to date, and only by welding operators who have been previously qualified to perform type of work required.

D. Damaged Joists: Do not use joists with cracked or improper welds or joists otherwise damaged so as to affect their structural properties. Field repair of such damaged joists will be allowed only by special permission and subject to review of the Architect. Method of repairs shall be in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 05320 - METAL FLOOR DECK

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Perform all work required to complete the metal floor deck work indicated by the Contract Documents and furnish all supplementary items necessary for its proper installation.

1.02 CODES AND STANDARDS:

A. The Work described in this section, unless otherwise noted on the Drawings or herein specified, shall be governed by the latest editions of the following codes or specifications:

1. "Specifications for the Design of Cold-Formed Steel Structural Members" - AISI.

2. "Structural Welding Code" - AWS D1.3.

1.03 QUALITY ASSURANCE:

A. Qualifications of welders and welding operators, filler metal, welding techniques and procedures shall be in accordance with AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings, and the AWS Structural Welding Code.

B. Certifications shall be no more than six (6) months old during the time of welding in the erection period.

1.04 SUBMITTALS:

A. Shop Drawings:

1. Submit shop drawings in accordance with Specifications.

2. Shop Drawings shall indicate decking plan, deck profile dimensions, anchorage requirements, projection, openings and reinforcement, finishes, applicable details and accessories.

B. Manufacturer's Data: Submit two copies of manufacturer's specifications and installation instructions for Metal Floor Deck. Include manufacturer's certification as may be required to show compliance with these specifications.

1.05 STORAGE OF MATERIAL:

A. Sheets shall be protected from the elements in transit. When stored at site, they shall be raised off the ground and be provided with weatherproof covering. The Architect may reject any material that has become damaged because of improper storage.

1.06 SEQUENCING/SCHEDULING:

A. Coordinate Work of this Section with work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Metal Floor Deck: Shall be as shown on the Drawings and shall conform to the requirements adopted by the Steel Deck Institute.

B. Galvanized Finish: Deck material to be galvanized shall conform to ASTM A446, Grade A, with a minimum yield strength of 33,000 psi. Before forming, surfaces shall be galvanized in accordance with ASTM A525 and Federal Specification QQS-775d, Type I, Class E -G90.

C. Welding Electrodes: Shall conform to AWS A5.1 and AWS A5.5.

D. Accessories: Provide all accessories necessary to complete the entire installation, including cover plates required to cover all gaps where deck units abut or change direction, around columns, to cover access holes used for welding, and closures where required.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Deck units shall be placed on supporting steel framework and adjusted to final position before being permanently fastened. Each unit shall lap a minimum of two inches (2") over supports.

B. Metal deck units shall be fastened to the steel framework at ends, side supports, and at intermediate supports as indicated on the Contract Documents. Provide weld washers for welding all material lighter than 22 gage.

C. Side joints of the deck unit shall be fastened by tack welding or mechanical fastening not more than 36" apart.

D. Tack weld or sheet metal screw all accessory cover plates adequately into place.

E. Weld metal shall penetrate all layers of deck material and shall have good fusion to the supporting members.

3.02 OPENINGS:

A. Openings shall be provided where shown on the Drawings, along with any reinforcing required to strengthen the metal deck.

B. Other openings and reinforcing not shown on Drawings will be made and reinforced by other trades and are subject to review by the Architect.

C. The Architect shall be immediately notified of any openings where supplemental framing is required but is not provided.

3.03 HANGING LOADS:

A. Mechanical equipment or other loads shall not be hung from metal deck unless shown on the Drawings. Method of attachment subject to review by the Architects.

3.04 TOUCH-UP PAINTING:

A. After decking installation, wire brush, clean and paint scarred areas, welds and rust spots on top and bottom surfaces of decking units and supporting steel members.

1. Touch-up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL:

A. Testing Laboratory services shall be in accordance with Section 01410.

B. Testing Laboratory shall perform field inspection of metal deck for proper type, gage, finish, installation and attachment. Testing Laboratory shall provide a written report of their inspection.

END OF SECTION

SECTION 06192 - PREFABRICATED WOOD TRUSSES AND BRACING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 WORK INCLUDED:

A. Includes furnishing all materials, equipment, transportation and facilities and performing all necessary for suppling the prefabricated wood trusses as indicated on drawings.

B. Types of prefabricated wood trusses include:

1. Gable-shaped trusses.

2. Hip and girder trusses at hip ends of roof.

3. Miscellaneous trusses.

1.03 DEFINITIONS:

A. Prefabricated wood trusses include planar structural units consisting of metal plate connected members which are fabricated from dimension lumber and which have been cut and assembled prior to delivery to the project site.

1.04 SUBMITTALS:

A. Product Data:

1. Submit fabricator's technical data covering lumber, metal plates, hardware, fabrication process, treatment (if any), handling and erection.

2. Submit certificate, signed by an officer of fabricating firm, indicating that trusses to be supplied for project comply with indicated requirements.

B. Shop Drawings:

1. Submit shop drawings showing species, sizes and stress grades of lumber to be used; pitch, span, camber, configuration and spacing for each type of truss required; type, size, material, finish, design values, location of metal connector plates; bearing and anchorage details, all connections details, temporary and permanent bridging and other accessories.

2. Submit design analysis and test reports indicating loading, section modulus, assumed allowable stress, stress diagrams and calculations, deflections, and similar information needed for analysis and to ensure that trusses and all bracing comply with requirements.

3. Provide shop drawings which have been signed and stamped by a registered structural engineer licensed to practice in the jurisdiction where trusses and bracing will be installed.

1.05 QUALITY ASSURANCE:

A. TPI Standards: Comply with applicable requirements and recommendations of the following Truss Plate Institute (TPI) publications:

1. "Design Specification for Light Metal Plate Connected Wood Trusses."

2. "Design Specification for Metal Plate Connected Parallel Chord Wood Trusses."

3. "Commentary and Recommendations for Handling and Erecting Wood Trusses."

4. "Commentary and Recommendations for Bracing Wood Trusses."

5. "Quality Standard for Metal Plate Connected Wood Trusses."

B. Wood Structural Design Standard:

1. Comply with applicable requirements of "National Design Specifications for Stress - Grade Lumber and It's Fastenings" published by N.F.P.A. (latest edition).

2. Comply with applicable requirements of "Timber Construction Standards" by American Institute of Timber Construction (latest edition).

C. Design by Manufacturer Trusses shall be designed by Connector-plate manufacturer to support all superimposed dead, live and wind loads indicated, with design approved and certified by a structural engineer licensed to practice in the jurisdiction where trusses will be installed.

D. Connector Plate Manufacturer's Qualifications: Provide truss connector plates manufactured by firm which is a member of TPI and which complies with TPI quality control procedures for manufacture of connector plates published in TPI "Quality Standard for Metal Plate Connected Wood Trusses."

E. Fabricator's Qualifications: Provide trusses by a firm which has a record of successfully fabricating trusses similar to type indicated and which complies with the following requirements for quality control:

1. Fabricator practices a quality control program which complies with, or is comparable to, one published in TPI "Quality Standard for Metal Plate Connected Wood Trusses" and which involves inspection by an independent inspection and testing agency acceptable to Architect and authorities having jurisdiction.

F. Single Source Responsibility for Connector Plates: Provide metal connector plates form a single manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Handle and store trusses with care, and in accordance with manufacturer's instructions and TPI recommendations to avoid damage form bending, overturning or other cause for which truss is not designed to resist or endure.

B. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying work of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide metal connector plates of one of the following:

1. Alpine Engineered Products, Inc., Clary Corporation, Mitek, Inc., or equal.

2.02 LUMBER:

A. Factory mark each piece of lumber with type, grade, mill and grading agency.

B. Lumber Standard: Manufactured lumber to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

C. Inspection Agencies: Inspection agencies and the abbreviations used to reference them to lumber grades and species include the following:

1. SPIB - Southern Pine Inspection Bureau.

2. WWPA - Western Wood Products Association

D. Nominal sizes are indicated, except as shown by detail dimensions.

E. Provide lumber manufactured to actual sizes required by PS 20 to comply with requirements indicated below:

1. Dressed, S5S, unless otherwise indicated.

2. Moisture Content: Seasoned, with 19 percent maximum moisture content at time of dressing and shipment for sizes 2" or less in nominal thickness, unless otherwise indicated.

3. Grade: As required by analysis.

4. Species: Southern Pine grade under SPIB rules.

5. Minimum Design Values: As indicated below:

a. FB (extreme fiber stress in bending): 1,050 psi.

b. E (Modules of elasticity): 1,400,000 psi.

2.03 METAL CONNECTOR PLATES, FASTENERS AND ANCHORAGES:

A. Connector Plates: Fabricate connector plates from metal complying with the following requirements.

B. Hot-Dip Galvanized Steel Sheet: Structural (physical) quality steel sheet complying with ASTM A446, Grade A; zinc coated by hot-dip process to comply with ASTM A525, Designation G60; minimum coated metal thickness indicated by not less than 0.036".

C. Electrolytic Zinc-Coated Steel Sheet: Structural (physical) quality steel sheet complying with ASTM A591, Coating Class C, and, for structural properties, with ASTM A446, Grade A; zinc-coated by electro-deposition; with minimum coated metal thickness indicated but not less than 0.047".

D. Fasteners and Anchorages:

1. Provide size, type, material and finish indicated for nails, screws, bolts, nuts, washers and other anchoring devices.

2. Provide "Hurricane Anchors" at all trusses.

2.04 FABRICATION:

A. Cut truss members to accurate lengths, angles and sizes to produce close-fitting joints with wood-to-wood bearing in assembled units.

B. Fabricate metal connector plates to size, configuration, thickness and anchorage details required for types of joint designs indicated.

C. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with close-fitting joints. Position members to produce design camber indicated.

D. Connect truss members by means of metal connector plates accurately located and securely fastened to each side of wood members by means indicated or approved.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General: Erect and brace trusses to comply with recommendations of manufacturer and the Truss Plate Institute.

B. Erect trusses with plane of truss webs vertical (plumb) and parallel to each other, located accurately at design spacings indicated.

C. Hoist units in place by means of lifting equipment suited to sizes and types of trusses required, applied at designated lift points as recommended by fabricator, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Provide temporary bracing as required to maintain trusses plumb, parallel and in location indicated, until permanent bracing and roof deck is installed.

E. Anchor trusses securely at all bearing points to comply with methods and details indicated.

F. Install permanent bracing and related components to enable trusses to maintain design spacing, withstand live and dead loads including lateral loads, and to comply with other indicated requirements.

G. Do not cut or remove truss members.

END OF SECTION

MEP SPECIFICATIONS INDEX

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 DEFINITIONS:

A. Approved: Unless otherwise stated, materials, equipment or submittals acceptable to the owner.

B. ANSI: American National Standards Institute.

C. ASTM: American Society for Testing and Materials.

D. AWS: American Welding Society.

E. AWWA: American Water Works Association.

F. Concealed: "Hidden from sight" as in shafts, furred spaces, in soffits or above suspended ceilings.

G. Contractor: The company awarded the prime contract for this work and any of its subcontractors, vendors, suppliers or fabricators.

H. Exposed: "Visible" or "not concealed."

I. FM Approved: Materials or equipment approved by Factory Mutual and included in the most recent edition of the FM Approval Guide.

J. Furnish: Supply materials to other trades for mounting or installation.

K. Install: Mount and connect equipment or assemblies provided by others.

L. NFPA: National Fire Protection Association.

M. Provide: Furnish, install and connect.

N. UL Listed: Materials or equipment listed by Underwriters Laboratories and included in the most recent edition of the UL Fire Protection Equipment Directory.

1.2 SCOPE OF WORK:

A. Work Provided:
   1. Site visit to determine existing conditions and extent of work.
   2. Complete wet pipe sprinkler system for the new building addition as well as the existing renovated building as outlined in these specifications and shown in the construction drawings, including all labor, materials and shop drawings. Requirements shall include:
      a. New 6" underground fire main, including valve, from the city water supply to the new sprinkler riser in the building. Piping shall be both rodded and blocked.
      b. Excavation and backfill for underground piping.
      c. New 6” double check valve-detector check assembly with two 6” gate valves in accordance with City requirements.
      d. 4" x 2-1/2” x 2-1/2” 2-way fire department connection with check valve and ball drip at the exterior wall.
      e. Control valves and alarm check valves including trim, water motor gong

or electric bell and other accessories.

f. Coordination of work with all other trades.

g. Shop drawings, operating instructions, valve diagrams and record drawings.

h. Waterflow and valve supervisory switches.

i. Instruction for the Owner's maintenance personnel on the proper operation and test procedures for all fire protection components provided, furnished or installed.

j. Payment of all permits, fees and charges required in connection with this work.

k. Performance of all tests and inspections required by the referenced codes and standards, local fire department and building department and the Owner.

B. Related Work:

1. Painting of sprinkler piping, hangers and valves, including placing and removal of bags or other protection devices on sprinklers to prevent paint from touching any portion of a sprinkler.
2. Cutting and patching.
3. Concrete splash blocks.
4. Connection of waterflow and valve supervisory switches to building fire alarm system.

1.3 QUALITY ASSURANCE:

A. Testing Agency: All material shall be UL listed and FM approved.

B. Regulatory Agencies: Local building codes and ordinances, fire department and fire prevention bureau requirements, the requirements of FM and the Texas Department of Insurance shall apply.

C. Reference Standards:

1. NFPA (Current Editions):
   a. 13 - Standard for the Installation of Sprinkler Systems.
   b. 24 - Standard for Outside Protection.
   c. 25 - Recommended Practice for Care & Maintenance of Sprinkler Systems.
   d. 101 - Life Safety Code.
2. ANSI (Current Editions):
   a. A21.10, A21.10a - Gray-Iron and Ductile-Iron Fittings, 2-inch through 48-inch for Water and Other Liquids.
   b. A21.51 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
   c. B16.1 - Cast Iron Pipe Flanges and Flanges Fittings, 24, 125, 250 and 800 pounds.
   d. B112.1 - Hose Valves for Fire Protection Services.
3. ASTM (Current Edition):
   a. A 53 - Specifications for Welded and Seamless Steel Pipe.
   b. A 135 - Black and Electro-Coated Seamless Steel Pipe for Ordinary Use.
   c. A 795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
   d. A 307 - Carbon Steel Externally and Internally Threaded Standard Fasteners.
4. FM Approval Guide (latest edition).
5. UL Fire Protection Equipment List (Annually with Quarterly Supplements).

6. AWS (Current Edition) D10.9 - Qualification of Welding Procedures and Welders for Piping and Tubing, Level AR-3.

D. Qualifications
1. Provide proof of licensure to install automatic sprinkler systems in the city, county and state, including compliance with contractor licensing procedures and state laws.

1.4 DESIGN CRITERIA:

A. Standard Sprinklers:

Remote Area	Density	Area	Inside Hose Allowance Location	Outside Hose Allowance Location
All Areas	0.10	1500	50 @ base of riser	50 @ supply point

1. Sprinkler system pipe sizing shall be determined by hydraulic calculations in accordance with NFPA 13.

1.5 SUBMITTALS:

A. Shop Drawings and Hydraulic Calculations:
1. Shop drawings shall include all piping, sprinklers, hangers, type of pipe, outlets, type of building construction and occupancy of each area.
2. When welding is planned, shop drawings shall indicate the section to be shop welded and type of welded fittings to be used.
3. Submit hydraulic calculations with shop drawings. Calculations shall include cover sheet, water supply, graph and all other information required by NFPA 13

B. Manufacturer's Data: Include installation, maintenance and testing procedures, dimensions, wiring diagrams, etc. for the following:
1. Sprinklers and escutcheons.
2. Pipe, fittings and hangars.
3. Control valves, detector check assembly, check valves and alarm check valves.
4. Test header or flow meter.
5. Waterflow and valve supervisory devices.
6. Fire hose valves
7. Water motor alarm or electric bell.

Where any devices which are provided or furnished involve work by another contractor, submit additional data copies directly to that Contractor.

C. Reviews
1. Submit six blueline prints of complete shop drawings, six sets of hydraulic calculations and six sets of manufacturers' data to the Architect and Local Fire Prevention Bureau for review and/or approval prior to fabrication of materials:

D. Test Certificates:
1. Upon completion of final inspections and tests, as required by appropriate NFPA Standards, submit copies of Standard Contractor's Material and Test Certificate.
2. Submit certificates from a testing laboratory certifying that the backfilling and compaction thereof is in accordance with the requirements, before final pavement is installed.

E. Operating Instructions:
1. At the completion of the work, provide a small scale plan of each building indicating the locations of all control valves, low point drains and inspector's test valves. The plans shall be neatly drawn and color coded to indicate the portion of the building protected by each system. The plan shall be framed under glass and permanently mounted on the wall adjacent to the riser.
2. Furnish copies of NFPA 25 and three bound sets of printed operating and maintenance instructions to the Owner.

F. Spare Parts:
1. Provide spare sprinkler cabinet in each building, complete with at least two sprinklers of each temperature rating in use throughout the installation. Each cabinet shall be equipped with 12 sprinklers and any special sprinkler wrenches required for each type of sprinkler installed.
2. Confer with the Owner's Representative for exact location of cabinet.

1.6 WARRANTY:

A. Warrant all materials and workmanship for a period of one year beginning with the date of final acceptance by the Owner. Warranty shall include 24 hours per day, seven days per week emergency repair service within four hours of a request for such service by the Owner.

PART 2 - MATERIALS

2.1 GENERAL:

A. All components shall be used in accordance with the manufacturer's recommendations and their UL listing and/or FM approval.

2.2 PIPE:

A. Pipe shall be new and shall have the manufacturer's name and brand along with the applicable ASTM standard marked on each length of pipe.

B. Steel:
1. Pipe shall be black.
2. Pipe exposed to atmosphere shall be galvanized.
3. Standard Wall:
a. Standard wall pipe shall comply with ASTM A 795 and ANSI B36.10. Schedule 40 pipe is considered "standard wall" pipe. Schedule 30 pipe is acceptable in sizes of 8-inch or larger.
b. Pipe ends shall be welded, threaded or cut grooved.
4. Thin Wall:
a. Thin wall pipe shall comply with ASTM A 53, A 135 or A 795.
b. Minimum pipe wall thickness for pressures up to 300 psi shall be:
1) Schedule 10 in sizes up through 5-inch.
2) 0.134 inches for 6-inch.
3) 0.188 inches for 8-inch pipe.
c. Pipe ends shall be roll grooved.
5. Light Wall:
a. Light wall pipe shall comply with ASTM A 53, A 135 or A 795.
b. Pipe ends shall be prepared in accordance with manufacturer's instructions and shall be welded or roll grooved.
6. Threadable light wall pipe shall not be used.

C. Underground:
   1. Ductile iron pipe shall be cement lined pressure Class 51 centrifugally cast ductile iron enameline.
   2. PVC underground pipe shall be pressure class 200 Blue Brute PVC or approved equal.

2.3 FITTINGS:

A. Changes of direction shall be accomplished by the use of fittings suitable for use in sprinkler systems as defined in NFPA 13.

B. Fittings exposed to outside atmosphere shall be galvanized.

C. Bushings shall not be used unless written approval is obtained from the Engineer.

D. Screwed fittings shall be cast iron, 125 pound, in accordance with ANSI B 16.4.

E. Flanged fittings shall be cast iron, short body, Class 125, black in accordance with ANSI B 16.1. Gaskets shall be full-face of -inch minimum thickness red sheet rubber. Flange bolts shall be hexagon head machine bolts with heavy semi-finished hexagon head nuts, cadmium plated, having dimensions in accordance with ANSI B 18.2.

F. Weld fittings shall be steel, standard weight, black, in accordance with ANSI B 16.9, ANSI B 16.25, ANSI B 16.5, ANSI B 16.11 and ASTM A 234.

G. Grooved couplings and mechanical fittings shall be malleable iron, 500 psi working pressure, in accordance with ASTM A 47. The couplings' gasket material shall be butyl rubber. Rigid grooved couplings shall be used in standpipe risers except in earthquake zones.

H. Push-on and “FIT” fittings shall not be used.

I. Underground fittings shall be Class 51 ductile iron mechanical joint or approved equal.

2.4 SPRINKLERS:

A. Sprinkler Heads

Area	Orifice	K Factor	Rating ºF	Finish	Type	Escutcheon	Style
All Areas	0.5 in.	5.6	165	Chrome	Pendent	Semi-Recessed	Chrome

B. Adjustable escutcheons shall not be used.

C. Exposed sprinklers in areas without ceilings shall be upright type. Pendent type may be used on wet pipe systems where necessary due to clear height requirements, interferences, etc.

2.5 FIRE HOSE VALVES:

A. Hose Stations shall include 2-1/2" valve with 1-1/2" adapter.

B. Hose threads for hose valves, wall hydrants and fire department Siamese connection shall match those of the local fire department.

2.6 VALVES & DEVICES:

A. Provide alarm check valves complete with trim, including water motor alarm or electric bell.

B. Inside Control Valves:
1. Provide OS&Y gate valves or gear operated butterfly valves.
2. Vane for butterfly valve shall be of symmetrical design.

C. Inspector's Test:
1. Provide inspector's test connections, as specified in NFPA 13, at most remote points in each system, for testing each Waterflow alarm device. Special discharge nozzle shall have same size orifice as smallest orifice sprinklers installed.
2. Provide 1-inch sight glass if inspector's test discharge cannot be readily observed while operating the valve.
3. Pipe test connection shall be piped to no more than 1'-0" above grade and discharged away from the building.

2.7 OTHER COMPONENTS:

A. Signs:
1. Provide standard metal signs per NFPA 13.
2. Provide hydraulic information signs at risers per NFPA 13.

B. Hangers:
1. Below concrete construction, inserts, powder driven studs, expansion cases or Phillips-type shells shall be installed to support the sprinkler piping. Expansion cases shall be installed in accordance with NFPA 13. Powder driven studs shall be tested in accordance with NFPA 13.
2. Below steel deck and joist construction, use beam clamps to hang piping from top chord of joist. Do not hang piping from bottom chord, or bridging.
3. If pipe weight exceeds 3 lb per square foot, contractor shall consult a structural engineer to determine appropriate hanger design.
4. Bulk mains shall be supported so that trapeze hangers between bar joists shall support only one bulk main and any bar joist shall be attached to only one trapeze hanger.

C. Drains:
1. Provide main drain valves at system control valves, sized per NFPA 13.
2. Plugs used for auxiliary drains shall be brass.

D. Fire Department Connection
1. Provide chrome plated 4” x 2-1/2" x 2-1/2" 2-way wall mounted fire department connection at location shown on the drawings. Installation shall be per city requirements.
2. Provide chrome nameplate, mounted at the base of each FDC, stamped with “Automatic Sprinkler”.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General:
1. Clean-up:
a. Maintain the premises free from accumulation of waste materials or rubbish caused by this work.
b. At the completion of the work, remove all surplus materials, tools, etc., and leave the premises clean.
c. Remove all burrs from pipe threads and fittings, and all debris and foreign material from inside all pipe and fittings before installation. Correct all system leaks prior to final acceptance.
d. Flush all piping in accordance with NFPA Standards for test procedures.
2. Safety:
a. Perform all work in compliance with the Occupational Safety and Health Act of 1970 and the Construction Safety Act Standards.
b. Attend all job site safety meetings.
3. Training:
a. Schedule training sessions at a time mutually agreeable to the Contractor and the Owner.
b. Conduct two training sessions of at least 2 hours each to familiarize building personnel with the operation and maintenance of the sprinkler system components.

B. Fire Sprinkler Components:
1. Overhead Piping and Fittings:
a. Support all sprinkler piping from building.
b. Support sprinkler lines under ducts with trapeze hangers from building structure or from steel angles supporting duct work in accordance with NFPA 13.
c. Install sprinkler piping in exposed areas as high as possible using necessary fittings and auxiliary drains to maintain maximum clear head room.
2. Sprinklers:
a. Install pendent sprinklers parallel to ceiling fixtures, walls, etc.
b. Provide sprinkler protection before combustible contents are in building.
3. Underground Piping:
a. Clamp and block all underground piping where required, in accordance with the requirements of NFPA 24.

3.2 DRAINS

A. Install all auxiliary drains where necessary. Terminate drain lines as shown on the attached sketch.

B. Pipe all drains to locations where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel.

C. High and low pressure drains shall not be connected.

3.3 ACCESSORIES

A. Install chrome finished ceiling and wall plates wherever exposed sprinkler piping passes through floors, ceilings and walls.

B. Sleeves:

1. Set sleeves in place for all pipes passing through masonry wall openings.
2. Space between sleeve and pipe shall be filled with noncombustible packing.
3. Sleeves through floors shall be watertight.

C. Provide flushing connections in cross mains as specified in NFPA 13.

3.4 FIRE DEPARTMENT CONNECTION

A. Properly connect fire department connection to system piping with necessary check valve and ball drip drain connection.

B. Install standard nameplate marked “Automatic Sprinkler.”

3.5 WELDING:

A. No field welding of sprinkler piping shall be permitted.

B. Headers, Risers, Feed mains, Cross mains and branch lines may be shop welded using acceptable welding fittings. Welding methods shall comply with all of the requirements of AWS D10.9, "Standard for Building Service Piping," Level AR-3. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler system.

C. Install a grooved coupling at each end of welded header.

3.6 INSPECTOR'S TEST:

A. Pipe all inspector's test connections discharging to atmosphere to location where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel. Pipe as shown on the attached sketch.

B. Install splash blocks where inspector's test discharge could produce damage to surroundings.

3.7 SYSTEM TESTS:

A. Scheduling:
1. Make arrangements with the Owner and Architect to schedule final inspection and witness final acceptance tests. If a scheduled final acceptance test is unsatisfactory, the Contractor shall be responsible for all time and expenses incurred by the Architect to conduct another test. These charges shall be deducted from payments made by the Owner to the Contractor.
2. Provide at least two working days notice prior to all flushing, trip tests and hydrostatic tests. Tests shall be scheduled to allow the Owner to witness them.

B. Testing Overhead Pipe:
1. Test all overhead sprinkler piping for a period of two hours, at a hydrostatic pressure of 200 psi or 50 psi above the highest pressure in the system in accordance with NFPA 13. All piping, valves, sprinklers, etc., shall be watertight. Notify the Owner’s Representative 48 hours in advance regarding the time and date of all tests.
2. Do not introduce water into any system during conditions when freezing can occur.

C. Flush and test all underground piping in accordance with NFPA 24.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The following provisions generally define materials and methods to be used in fabrication, erection, and installation of piping systems and components. These provisions are in addition to the requirements included in the Piping Systems Sections and Drawings and are intended to supplement the Piping Systems Sections and Drawings. In case of conflict, the Piping Systems Sections and Drawings shall take precedence over this Section.

1.2 QUALITY ASSURANCE

A. General: Provide pipe, valves, fittings and specialties, unless otherwise specified, that are new, full weight, full length, scale-free and best quality of their respective kinds.

B. In addition to tests required for specific materials and systems, the manufacturer shall test or guarantee all materials to be as specified prior to delivery.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions.

B. Shop Drawings: Submit in accordance with Section 23 00 00 - General Mechanical Provisions.

1.4 PRODUCT HANDLING, DELIVERY AND STORAGE

A. Delivery, handling and storage of materials covered by this section shall conform to the requirements of Section 23 00 00 - General Mechanical Provisions.

B. Handling: Receive and handle all materials with care so as not to cause damage. Use padded or strap slings, etc. as appropriate for the materials being handled. Stainless steel shall not be allowed to contact carbon steel during handling, storage, or installation. Lift equipment by lift points provided or recommended by the manufacturer.

C. Delivery: Upon receipt, inspect all materials for defects and for compliance with specifications. Tag, stencil, or otherwise permanently identify all materials with particular care to adequately identify specialty items.

D. Storage: Properly store all pipe, piping materials, etc., so as to prevent deterioration while in storage. Store all materials off the ground or floor. Store inside or cover all materials subject to deterioration from weather. Store all stainless steel on wood. Remove all rust spots which appear on stainless steel by brushing (using a stainless steel brush), pickling, passivating.

E. Store loose materials such as fittings, gaskets, bolts, nuts, small valves, traps, and specialties in bins of sufficient number to provide proper separation. Protect the ends of large fittings, valves and pipe from the weather and abuse. Properly grease all machined surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Deviations from specified materials may be required due to availability. These deviations are permissible if they are equal to or better than the specified materials for the purpose for which used and if approved by the Owner's Representative.

B. Pipe and Tube:

1. Pipe and Tube Specifications: Provide pipe and tube of the material and dimensions specified in the service specifications.
2. In general, fittings used for the various piping systems shall be as listed below. Special fittings shall be used where required by job conditions and when approved for particular use.
3. Fittings for copper tubing shall be Chase Sweat Fittings, Mueller Brass Company's "Streamline" solder fittings or approved equal. Drainage type fittings shall be used wherever possible. All solder for copper tubing shall be 95-5, Silfos or Eutectic No. 180F. All piping shall be installed in a workmanlike manner, according to the manufacturer's instructions. All joints shall be thoroughly cleaned before connecting. Silfos solder shall be required on all refrigerant piping joints.

2.2 INSULATING FITTINGS

A. Except that no dielectric fitting shall be installed in connections between copper or brass and sanitary cast iron waste, drain and vent lines, wherever an interconnection is made between ferrous pipes or vessel and copper tubing or brass pipe, or vice versa, install a dielectric fitting.

B. In lines assembled with screwed or soldered joints, use insulating couplings (unions) suitable for the intended service and where flanged connections are required, use insulating gasket material between flange faces, insulating grommets between bolts and holes in flanges and insulating washers under both bolt heads and nuts.

C. PVC couplings of any kind shall not be acceptable for insulating couplings.

D. Insulating fittings shall be suitable for the service medium, operating pressure and temperature.

E. Insulating fittings shall be as manufactured by EPCO, Maloney, or Crane.

2.3 VALVES

A. All valves of any one type shall be of the same make throughout and insofar as practicable all valves in a given category shall be of the same make.

B. All valves shall be so located as to be readily accessible for operation and maintenance.

C. Furnish and install all valves indicated on the Plans, specified herein, or required to control the flow of water to and from various parts of the systems and to isolate various pieces of machinery and equipment and to isolate various parts of the systems.

D. Each valve for installation in a line to be insulated shall have sufficient clearance between the valve body and the operating handle or device to accommodate the insulation.

E. All valves which must be used during operation, all control valve assemblies, instrument control cases, liquid level controls, gage glasses, orifices, relief valves, and other equipment which must be observed, adjusted, or serviced during operation shall be located conveniently accessible from an operating platform or grade.

F. Except where special valves are specified elsewhere herein or as required by special conditions or class of work, valves shall be equivalent to the following Crane Co. valve numbers:

1.

Type	Size	Crane Number
Gate	2" and smaller	428
Gate	2-1/2" and larger	465-1/2

Angle	2" and smaller	16-1/2 P
Angle	2-1/2" and larger	353
Check	2" and smaller	37
Check	2-1/2" and larger	373

2. Valves shall be as manufactured by Crane, Stockham, or Nibco.

G. Where shown on Plans, or in lieu of gate valves in water lines 2" and smaller, the Contractor may furnish ball valves. Ball valves shall be the equivalent of a Nibco T5954. Ball valves may also be used in lieu of plug valves for balancing purposes for lines 2" and smaller. Provide memory stops where used for balancing or as shown or detailed.

2.4 PIPE HANGERS

A. Pipe hangers (except fire protection) shall be Fee and Mason of a type suitable for each use. Perforated straps shall not be used in any work.
1. For ferrous pipes up to and including four inches (4") in size, use Fee and Mason Fig. 199 malleable iron, adjustable, split ring, swivel hanger.
2. Where several pipes are parallel at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on roller where rollers are called for by these specifications.
3. For copper pipes up to and including three inches (3") in size, use Fee and Mason Fig. 360 malleable iron, copper plated hangers. For copper pipes larger than three inches (3"), use Fee and Mason Fig. 364 copper-plated clevis hanger.

B. Hanger rod sizes shall conform to the following schedule:

Pipe up to 2"	3/8" rods
Pipe 2-1/2" to 3-1/2“	1/2" rods
Pipe 4" and 5"	5/8" rods

C. Unless shown otherwise on the Plans, all horizontal runs of ferrous piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to 1-1/4"	8 feet
Pipe 1-1/2" and 2"	10 feet
Pipe 2-1/2" and 3"	12 feet
Pipe 3-1/2" and 4"	14 feet

D. Unless shown otherwise on the Plans, all horizontal runs of copper piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to 3/4"	5 feet
Pipe 1" and 1-1/4"	6 feet
Pipe 1-1/2" and 2"	8 feet
Pipe 2-1/2" and larger	10 feet

E. Unless shown otherwise on the plans, all horizontal runs of CPVC piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the flowing maximum spacing:

Pipe up to 1”	3 feet
Pipe 1-1/4” and larger	4 feet

F. There shall be a hanger within two feet (2') of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps. Vertical pipes within a space shall have not less than two (2) supports.

G. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting; nor shall it be supported from equipment connections.

H. Beam clamps suitable for use with the type of steel construction involved shall be Fee and Mason Fig. 249 beam clamps, Fee and Mason Fig. 255 "C" clamps, Fee and Mason 285 side beam clamps, or Fee and Mason 252 or 253 adjustable beam clamps as required.

I. For insulated piping, hangers shall be sized to go around the insulation with saddles being provided to protect the insulation.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship: Execute fabrication and installation in the best and most workmanlike manner by qualified, careful, and efficient mechanics in strict accordance with the Drawings and Specifications. When work is not being performed on pipe, including at the end of work each day, plug openings to prevent entry of foreign matter.

B. Routing: Piping Drawings are generally to scale but place piping, etc. by calculated dimensions rather than dimensions scaled from Drawings. Route piping by the shortest run consistent with good installation practice, clearance requirements, and expansion and flexibility provisions. Arrange piping to facilitate support of the piping and ease of removal for inspection or servicing. Keep maintenance areas clear of piping. Cut pipe and hang to align freely with flanges and fittings.

C. Fabrication
1. The location, direction, and size of all lines are generally indicated on the drawings. Branch connections in general are indicated and shall be so installed as to provide proper grades.
2. All lines shall be made up straight and true at proper grades. Condensate lines shall grade down to drains.
3. Piping shall follow as closely as possible the routes shown on the plans and take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.
4. Install piping to coils, pump and other equipment at full size indicated on drawings with size reductions installed at equipment.
5. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.
6. Screwed Threads: Clean cut screwed threads with no stripping, or burrs from cutting or threading, in accordance with ANSI B2.1. Dies shall be new, sharp, and properly designed for the piping material. Immediately before erecting the piping, thoroughly clean all threads on pipe and fittings of all cuttings, dirt, oil or other foreign matter. Liberally coat male threads with thread lubricant or TFE thread tape and make up piping sufficiently for the threads to seize. Use TFE tape on all stainless steel threaded joints. Do not mar or damage pipe and fitting surfaces. Do not use Permatex, lampwick, cork, wool, or any other similar material for thread sealant.
7. Dielectric couplings shall be installed where ferrous pipe joins copper lines and shall be rated for the intended medium pressure and temperature or service.

8. Unions: Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of systems. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items or coils, machinery items and other special pieces of apparatus. Unions in 2" and smaller lines shall be ground joint and unions 2-1/2" and larger shall be flanged unions. Unions shall be the same material and strength as other fittings in the lines. Companion flanges on lines at various items of equipment, machines, and pieces of apparatus shall serve as unions to permit removal of the particular item.
9. All piping shall be supported by hangers independently of equipment connections.
10. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
11. This Contractor shall keep all open ends of piping in each system plugged or capped to prevent dirt or other debris from entering the pipe at any and all times during construction and/or before fixtures or equipment is connected. All piping shall be flushed clear prior to connection to the central building systems.
12. The ends of all piping furnished and installed in all systems shall be thoroughly reamed to the full inside diameter of the respective pipe.
13. Exposed lines shall be run parallel with, or perpendicular to building lines and wherever possible shall be grouped together for easy service and identification. Whenever possible, horizontal and vertical runs shall be held as close as possible to the walls, ceilings, struts, members, etc., so as to occupy the minimum space consistent with the proper installation requirements for insulation, conduit, ductwork, lighting fixtures, etc., and the expansion requirements of each of these items and the building proper or the removal of the respective or adjacent pipes, conduits, and ductwork, and/or to allow for necessary access to valves, other pipes, conduits, dampers, etc.
14. Valves required for control or isolation of any part of the various systems shall be provided and shall be located in approved or accessible positions or made accessible through removable panels, etc., and where several valves are related as to function, they shall be grouped in a battery. This Contractor shall arrange with the General Contractor for proper location of all access panels required for valves, etc. subject to approval of the Owner's Representative.
15. Where new lines are indicated to connect into existing lines, careful coordination shall be exercised to determine exact elevations and locations of existing lines, to establish grades of interconnecting new lines, to establish procedures to interconnect lines, and to establish other details.

3.2 CROSS CONNECTION AND INTERCONNECTIONS

A. No plumbing fixtures, device, or piping shall be installed which will provide a cross connection or interconnection between a distributing water supply for drinking or domestic purposes and a polluted supply such as drainage system, or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water, or waste into the water supply system.

3.3 EXCAVATION AND BACKFILLING

A. Provide necessary excavating and backfilling for the installation of work specified in this Division. Refer to Soils Investigation and Geotechnical Report for additional requirements.

B. Trenches for underground piping and conduits shall be excavated to required depths with bell holes provided as necessary to insure uniform bearing. Care shall be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where poor soil conditions are encountered, or where pipe is laid in a fill area, place and thoroughly compact a bed of 3/16" maximum size screened gravel in trench bottom to provide adequate support for piping. Where pipe is laid in rock trenches, bed in at least 6" of sand.

C. Alignment: Install piping to conform accurately to lines and grades shown on Drawings. Run utility lines perpendicular to curbs and building lines, unless otherwise shown or noted. Make all building connections through sleeves provided in walls or concrete floors. Where grades and slopes of gravity drain lines are not shown on Drawings, install 4 inch and larger drains at a uniform grade of not less than 1/8 inch per foot. Slope underground gravity drains smaller than 4 inch, 1/4 inch per foot, minimum.

D. Pipe Crossings: Lay lower pipe first and thoroughly compact backfill to level of higher pipe before higher pipe is laid. Maintain minimum clearance of 12 inches between pipes. Backfill material under such conditions shall be crushed stone, gravel or concrete as directed.

E. After the pipe has been installed, tested, and approved, the trenches shall be backfilled with eight inches (8"), in each direction surrounding the pipe, of sand or gravel free of rocks, metal, or other foreign materials and to grade with approved material, well tamped or puddled compactly in place.

F. Do not proceed with back-fill operations until piping has been inspected by the Owner's Representative. Do not perform backfilling operations, except in the presence of the Owner's representative. This Contractor shall give the Owner's Representative 24 hours notice for such observation.

G. All piping outside the building shall be installed below the frost line. Where streets, sidewalks, etc., are disturbed, cut or damaged by this work, the expense of repairing same in a manner approved by the Owner's Representative shall be part of this contract.

H. Contractor shall bear sole responsibility for design and execution of acceptable trenching and shoring procedures, in accordance with State Law. On trench excavations in excess of five feet in depth, Contractor shall pay a qualified engineer to prepare detailed plans and specifications directing Contractor in the safe execution of trenching and shoring. It is understood that trench safety systems constitute a means and method of construction for which the Architect, Engineer, and Owner are not responsible. Accordingly, such documents when prepared, shall be separately issued by Contractor's Consultant, independent of project Contract Documents.

3.4 FLASHINGS

A. Flash around all pipes passing through the roof in connection with this contract, with sheet lead weighing not less than 4 lbs. to the square foot built a minimum of 10" into the roofing, in all directions from the outside of the pipe running up the pipe a minimum of 10" and more where vent terminals must be higher to conform to the requirements of the local Plumbing Code, and then turned over one inch (1") into the pipe cavity. All seams and joints shall be completely soldered closed and the entire flashing shall be completely waterproof.

B. Make all roof penetrations in accordance with the roofing system manufacturers approved methods.

3.5 PIPE INSULATION SADDLES

A. Provide a section of Foamglas insulation, calcium silicate, cellular glass or 7#/cu.ft. fiberglass insulation of thickness specified at hanger support locations and provide galvanized steel protection saddles at hanger locations. Saddle shall be half cylinders with hemmed edges.

B. Refer to Section 22 07 00, Insulation.

3.6 SLEEVES AND SHIELDS

A. Provide all pipe penetrations through walls, partitions, and slabs with sleeves large enough to adequately accommodate the pipe plus any insulation and thermal movement. In no case

shall such sleeves be less than 1 inch larger than the outside diameter of the pipe or pipe insulation.

B. Install sleeves through the interior walls and partitions flush with standard surfaces; sleeves through outside walls to project 1/2" on each side of the finished wall and floor sleeves to project 3" above finished floors.

C. Set sleeves in place before pouring concrete or securely fasten and grout with cement. Set wall sleeves as wall is constructed. Where sleeves are inadvertently omitted from concrete floor or masonry walls, core drill sleeve unless use of jackhammer or other method is approved by Owner's Representative. For sleeves through interior walls, fill space between outside of pipe or insulation and inside of sleeve or framed opening with mineral wool or neoprene. For sleeves through exterior walls, pack with oakum, seal with link seal units.

D. Provide escutcheons and floor or ceiling plates on both sides of penetration through walls, floors, ceiling and partitions, whether or not insulated, for all pipes exposed to view in finished areas. Provide chrome plated brass escutcheons in finished areas.

3.7 TESTING AND REPAIRING

A. Each Contractor shall, at his own expense, during the progress of the work or upon its completion, make such tests of his work as are herein specified, or as required by the Owner's Representative, or by State or Municipal Bureaus having jurisdiction and under their supervision.

B. The Contractor shall provide all apparatus, temporary piping connections, or any other requirements necessary for such tests. He shall take all due precautions to prevent damage to the building and its contents incurred by such tests as he will be required to repair and make good, at his own expense, any damage so caused. Testing of insulating piping shall be done before insulation is applied.

C. Perform any other tests as may be required by the Owner's Representative to indicate the fulfillment of the specifications.

D. Systems shall be tested in portions as required by the construction schedule and the portions being tested shall be effectively isolated and sealed off. When previously tested sections are connected into other sections, tests shall be re-run to include the new connections.

E. Partial systems shall be tested prior to connecting into existing lines.

F. Leaks in screwed joints shall be repaired by tightening the joint until the leak has stopped, or by remaking the joint if tightening fails to stop the leak. Leaks in welded joints shall be repaired by chipping out the weld around the leak and rewelding until it is stopped. Leaks in caulked joints shall be stopped by additional caulking of the joint, but, if that fails, the joint shall be re-made. A leak in a compression joint shall be repaired by remaking the joint using a new seal, compression ring, coupling, etc., as required. Leaks in soldered joints shall be repaired by remaking the joint and no soldering or brazing over existing joints will be permitted. Any defective piping shall be replaced.

G. Additional testing shall be as specified in the individual Sections of this Specification.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 DESCRIPTION

A. This specification shall cover the furnishing of all materials, labor, equipment and accessories necessary for the installation of the insulation as herein specified. Insulation shall be installed in strict accordance with this specification, all applicable drawings, approved shop drawings and submittals and manufacturer's recommendations.

1.3 DEFINITIONS

A. For the purpose of this section of the specifications, the following definitions shall apply:

1. "Exposed Areas" shall be interpreted as piping and ductwork exposed to view within the building where function and appearance are considerations.
2. "Concealed Areas" shall be interpreted as areas within the building above finished ceilings or in chases where pipes and ductwork are not visible from the floor.
3. "Exterior Areas" shall be interpreted as areas outside the building which are exposed to weather above grade where function, appearance and weather protection are considerations.

1.4 QUALITY ASSURANCE

A. Notify in writing the Owner's Representative of the insulation schedule so that he may observe all insulation before it is concealed from view.

B. The Contractor is hereby forewarned that non-compliance of the specifications, substitution of materials without prior written approval, and failure to follow insulation material manufacturer's recommendations or approved submittals will result in disapproval of the insulation work.

C. Insulation shall be applied only by mechanics skilled in the trade and continuous supervision of the mechanics by a competent foremen is mandatory.

D. Certain kinds or quality of materials are specified. Approval by the Owner's Representative must be obtained for the particular items that the Contractor proposes to use before purchase orders are placed.

1.5 LIMITATIONS

A. Materials specified shall be applied subject to their temperature limits. Any methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.

1.6 FIRE RESISTANCE

A. Insulation, adhesive, sealer, vapor-barrier coatings and vapor-barrier materials shall have a flame-spread rating of not more than 25 and a smoke developed rating of not more that 50.

Materials that are factory applied shall be tested as assembled and certified by the manufacturer to meet standards. Materials which are field applied may be tested individually. No fugitive or corrosion treatments shall be employed to impart flame resistance.

1. Flame Spread and Smoke Developed Ratings: Shall be determined by Method of Test of Surface Burning Characteristics of Building Materials, NFPA No. 255, ASTM E84 and Underwriters' Laboratories, Inc. Building Materials List under heading "Hazard Classification (Fire)."

1.7 SUBMITTALS

A. Submit manufacturer's literature in accordance with the requirements of Section 23 00 00 - General Mechanical Provisions.

B. Submit manufacturer's data and literature of each insulation, cement, adhesive, sealer, mastic, vapor barrier, covering and cloth. The submittal data shall include but not be limited to the following:

1. Thickness of Insulation
2. Density
3. Maximum Temperature Limit
4. Fire and Smoke Hazard Ratings
5. Thermal Conductivity
6. Permeability of Insulation and Finishes
7. Moisture Absorption Data
8. External Facing Covering Type
9. Description of:
   a. Adhesives
   b. Mechanical Fastening System
   c. Application, Finishing and Flashing

1.8 GUARANTEE

A. Products and workmanship specified in this Section of the Specifications shall comply with the Guarantee Section of 23 00 00 - General Mechanical Provisions.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs define necessary characteristics of materials specified and possible sources. Materials by manufacturers other than those specified herein will be acceptable, provided such materials conform to the specified characteristics.

2.2 PIPING INSULATION

A. Class I insulation shall be heavy density preformed one-piece single seam insulation composed of fine inorganic glass fibers bonded together with a thermosetting resin with an all service jacket composed of white kraft paper bonded to aluminum foil and reinforced with glass fiber yarn, conforming to the following:

Maximum Temperature Limit, ºF	500
Density, lbs/cf	4.0 to 7.0
Specific Heat, BTU/lb/ºF	0.20
Thermal Conductivity, BTU/hr/sq.ft./ºF/in.	
at 75ºF	0.23
200ºF	0.26
400ºF	0.42
Jacket Water Vapor Permeability	0.02

B. Class II insulation shall be heavy density preformed one-piece single seam insulation composed of fine inorganic glass fibers bonded together with a paper bonded to aluminum foil reinforced with glass fiber yarn and factory applied pressure sensitive adhesive self sealing longitudinal overlap and end joints, conforming to the following:

Maximum Temperature Limit, °F	500
Density, lbs/cf	4.0 to 7.0
Thermal Conductivity, BTU/hr/sq.ft./°F/in.	
at 75°F	0.23
200 °F	0.26
400 °F	0.42
Jacket Water Vapor Permeability	0.02

C. Class III insulation shall be expanded closed-cell elastomeric, conforming to the following:

Maximum Temperature Limit, °F	-40 to 220
Density, lbs/cf	4.5 to 8.5
Combustibility	Self-Extinguishing
Thermal Conductivity, BTU/hr/sq.ft./°F/in.	
at 75°F mean temperature	0.27
90°F mean temperature	0.276
Water Vapor Permeability	0.08

D. Coatings, Sealers and Mastic

1. Mastic vapor barrier for low and medium temperature equipment and pipe insulation shall be white with perm rating not to exceed 0.02. Mastic vapor barrier for high temperature equipment and piping shall be a white mildew-resistant, fungi-resistant, vapor-resistant, weatherproof plastic resin (polyvinyl acetate, polyvinyl acrylic or copolymer) coating capable of adhering canvas or glass to calcium silicate or fiberglass.
2. Lagging and sizing adhesive for applying canvas and glass cloth to fibrous glass, polyurethane, mineral wool and calcium silicate insulation shall be white with a perm rating not to exceed 1.0 and shall have a temperature range of -20 to 180 degrees F.
3. Permanently flexible vapor barrier sealant for low and medium temperature applications shall be white with a perm rating not to exceed 0.01 and shall be suitable for temperatures to 300 degrees. Permanently flexible vapor barrier sealant for high temperature applications shall be black with a perm rating not to exceed 0.01 and shall have a maximum temperature limit of 500 degrees F.
4. Flexible elastomer sealer shall be an air drying contact adhesive for joining seams and butt joints of flexible elastomer insulation and shall have a temperature range of 0 to 220 degrees F.
5. High strength, neoprene contact adhesive for bonding low and medium temperature equipment and pipe insulations with reinforced foil faced kraft laps, glass fiber cloth, foils and laminated and film vapor barriers shall have a temperature range of -30 to 275 degrees F.
6. Sodium silicate base fibrous adhesive for bonding high temperature equipment and pipe calcium silicate insulation to non-porous surfaces shall have a temperature range of 40 to 850 degrees F.
7. Finish coating shall be a white, creamy odorless, non-toxic finish, resistant to most mild acids and alkalies, that provides a smooth, flexible, fire-resistive finish and shall have a temperature range of -20 to 180 degrees F.

E. Fiber-Glass Cloth shall be a high-strength, fiber-glass cloth, 0.03 inch thick, 5.8 ounces per square yard with an open weave for complete penetration of mastic.

PART 3 - EXECUTION

3.1 GENERAL

A. Before any insulation is applied, all piping shall be thoroughly cleaned, tested and made tight. All systems requiring a hydrostatic or pneumatic test shall have the test completed and approved by the Owner's Representative before the insulation is applied. Insulation shall be applied to pipe surfaces only when these surfaces are clean and completely dry. Any insulation that is wet from condensation, rain or other source shall be removed and new insulation installed.

B. All insulation shall be installed according to the manufacturer's recommendations, and workmanship shall be first-class in every respect. Joints shall be tightly butted, and the covering shall be applied tight and smooth, the insulation shall be cut and fitted neatly around irregular surfaces and the insulation materials securely attached to the pipe. Jacket seams shall be cut with a sharp knife or scissors, not ripped, and the seam applied to the least conspicuous side where finish coats of sealer, vapor barrier or other fluid materials are sprayed, painted or troweled on, these coats shall be applied to the full thickness specified and shall be uniform without ridges, pigtails, bubbles or holidays.

C. Adhesives, sealers, vapor barrier coatings, etc., shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state.

D. Insulation shall be neatly finished at pipe hangers. All cold pipes or pipe insulation which is totally vapor sealed shall have pipe hangers on the outside of the insulation and hangers shall be equipped with insulation shields. Metal jacketed pipes shall have hangers or supports equipped with metal saddles of the same material as the jacket. Pipe insulation shall be continuous through walls, floors, ceiling openings, hangers, supports and sleeves.

E. Provide vertical pipe lines with sheet metal insulation supports at intervals not to exceed 15 feet. Supports shall be T304SS (type 304 Stainless Steel). Whether inside or outside, flash all penetrations of insulation with metal and/or waterproof sealing compound so that water cannot stand or enter from above. On horizontal lines, longitudinal seams of metal jackets shall be sealed to drain and jacket laps, if any shall also be installed to drain. Flash insulation terminations and seal with care to keep liquid out.

F. Flange Covers at Equipment: Provide removable type covers on flange fittings between equipment and piping. Fabricate a frame made in two half sections of 1" hex, monel mesh x 0.032" three twist monel wire to which block or sectional insulation is attached. Flange cover shall extend 2" over ends of adjacent pipe insulation with the ends of the pipe insulation terminated, beveled and finished as specified. After the frame is insulated, the inside and outside shall be finished with insulation cement same as for Class of insulations used on piping service. The two half sections of removable flange covers shall be held in place with 1/2" x 0.020" thick stainless steel bands (2 minimum per cover) after the specified finish has been applied to insulation.

G. Application Temperature: No insulation shall be applied or cured in ambient temperatures below 40°F. Insulation applied or cured in ambient temperatures below 40°F. shall be removed and replaced by the Contractor at no expense to the Owner.

H. Modifications to Existing Insulation: Where existing insulation is disturbed or damaged during the process of installing other new materials, making new connections, etc., it shall be repaired or replaced to return it to its original condition and appearance. Where existing lines are removed and connections to insulated lines are capped, insulate those caps as well as repairing damaged insulation. Materials shall match those presently installed in thickness, density, insulating value, jacketing, etc.

I. Shields: Metal saddles shall be applied between hangers or supports and the pipe insulation. Saddles shall be formed to fit the insulation and shall extend up to the centerline of the pipe and shall be of the length specified herein. Shields shall be made of galvanized sheet metal and shall be of sufficient size and length to prohibit the crushing of the insulation materials. Saddle shields shall be as follows:

METAL SADDLES

PIPE SIZE	METAL GAUGE	LENGTH
1/2" to 3"	16	12"
4" to 10"	12	16"
12" & larger	10	18"

J. Inserts: Provide inserts of calcium silicate on hot piping and cellular glass or 7#Cu.Ft. fiber glass pipe insulation on cold piping at hangers. Inserts between the pipe and pipe hangers shall consist of rigid pipe insulation of a thickness equal to the adjoining insulation and shall be provided with vapor barrier where required. Insulation inserts shall not be less than the following lengths:

PIPE SIZE	INSERT LENGTH
1/2" to 3"	12"
4" to 10"	16"
12" & larger	18"

K. Material Changes: Wherever there is a change in materials on lines that are vapor sealed, apply a suitable adhesive that is compatible with both materials, tapes, etc., as required to maintain the vapor barrier.

3.2 PIPING INSULATION APPLICATION

A. Class I Insulation Application:

1. Class I insulation with integral jacket shall be applied to piping systems with joints firmly butted together and jacket longitudinal flap on top for horizontal pipe and on the least conspicuous side of vertical pipe. Apply a brush coat of mastic vapor barrier on both contact surfaces, the overlapping jacket flap and the insulation jacket. At butt joints, apply brush coat of mastic vapor barrier on both the pipe insulation jacket and the butt strips. Butt strips shall be a minimum of four inches (4") wide and of the same material as the insulation jacket. Apply vapor barrier sealant to cover all overlapping jacket flap seams and butt strip seams.
2. Fittings, valves, flanges, unions, and strainers shall be completely covered with pre-molded fiberglass insulation or fabricated metered sections of the same thickness and density as the adjoining pipe covering. Smooth and level the insulation with mastic vapor barrier and seal all seam edges. The circumferential edges shall be wrapped with butt strips, minimum of four inches (4") wide, with mastic vapor barrier applied to the entire inside surface and the outside surface seams. All valve stems and operators and strainer clean-out covers shall be left exposed for normal operations.
3. In exposed areas the insulation shall be additionally finished with a skim coat of insulating cement over which a wrapping of open mesh glass cloth shall be embedded between two (2) uniform flood coats of lagging.
4. In exterior areas the entire insulation jacket shall be coated with vapor barrier sealant and covered with an aluminum jacket. All fittings, tees, elbows, valves, etc. shall be covered with factory fabricated aluminum fitting covers. All aluminum jacket seams and joint butt straps shall be coated with vapor barrier sealant.

B. Class II Insulation Application:

1. Class II insulation with integral jacket and self-sealing overlapping jacket flap shall be applied to piping systems with joints firmly butted together and jacket longitudinal flap on top for horizontal pipe and on the least conspicuous side of vertical pipe. Seal longitudinal overlapping jacket flap from the middle outward by pulling the flap tight. At butt joints, apply self-sealing butt strips tight around the butt joints. Butt strips shall be a minimum of four inches (4") wide and of the same material as the insulation jacket.
2. In exposed areas the insulation shall have a smoothing finish coating applied to the entire insulation jacket.
3. In exterior areas the insulated pipe system including elbows, fittings, valves, unions, etc., shall be covered with an aluminum jacket.
4. Fittings, valves, flanges, unions, and strainers shall be completely covered with pre-molded fiber glass insulation or fabricated metered sections of the same thickness and density as the adjoining pipe covering. Smooth and level the insulation with moisture vapor barrier and seal all seam edges. The circumferential edges shall be wrapped tight with self-sealing butt strips, a minimum of four inches (4") wide. All valve stems and operators and strainer clean-out covers shall be left exposed for normal operations.

C. Class III Insulation Application:

1. Class III Insulation shall be applied to piping systems by slipping unsplit insulation on pipe prior to connection wherever possible to avoid seams in insulation material. Open ends of pipe shall be capped or plugged before insulation is slipped on pipe. Thoroughly seal butt joints in insulation with adhesive. Where slip-on technique is not possible, split tubular insulation longitudinally in a straight line and apply around pipe, and thoroughly seal longitudinal seams and butt joints with adhesive.
2. Fabricate and install fitting cover insulation according to manufacturer's recommended procedures. Insulate sweat fittings with mitercut pieces of insulation the same size as adjoining piping. Seal metered joints and seams of insulation with adhesive.
3. Provide rigid pipe insulation on all piping at pipe hanger locations. Protect rigid insulation with 26 gauge galvanized steel pipe saddles installed between each hanger and the rigid insulation. Each saddle shall be a minimum of 3" wide and formed to fit curvature of insulation surface. Seal all joints between normal and rigid insulation with adhesive.
4. Following the installation of the adhesive, thoroughly dry and clean all surfaces of insulation with a non-oily solvent. After the insulation is dry, apply two (2) coats of Armaflex Finish in the manner recommended by the manufacturer.

3.3 PIPING IDENTIFICATION

A. Furnish piping identification markers for all insulated piping systems in sizes and colors in accordance with ANSI A13.1. Markers shall be as manufactured by Seton Name Plate Corporation, EMED or Craftmark equal to their roll form markers with pressure sensitive arrows on a roll securing both ends of marker wrapped completely around pipe.

B. Provide flow arrows at each marker location.

C. Markers shall be spaced not more than 20 feet on center and at each change of direction not more than 4 feet from each elbow.

D. Apply markers only after insulation system is complete to include aluminum jacketing as applicable and sizing and painting of canvas jacketing as applicable. Apply adhesive to area where markers are to be installed.

3.4 INSULATION SCHEDULE

A. Piping:

Insulation Service	Insulation Class	Thickness
Domestic Cold Water Piping	I	1"
Domestic Hot Water Piping		
Up to 1-1/4” diameter	II	1”
1-1/2” to 2” diameter	II	1-1/2”
Over 2”diameter	II	2”
Condensate Drain Piping	III	3/4"
Horizontal Storm Drain Piping (Including Roof Drains)	I	1-1/2"
Circulating Domestic Hot Water Supply and Return Piping		
Up to 1-1/4” diameter	II	1”
Over 1-1/4” diameter	II	2”

END OF SECTION

SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide a complete domestic hot and cold water distribution system as indicated herein and as illustrated on the Contract Drawings.

B. Provide isolation of systems through valving as shown or indicated herein.

C. Provide a system free of water hammer.

D. Isolate all piping components to eliminate all audible vibration and noise.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00 - General Mechanical Provisions.

B. Indicate on submittal piping material and joining method for each system and for the various sizes of piping systems to be installed. This shall be in tabular form in one location.

C. Product Data:
1. Pipe and fittings.
2. Joining methods.
3. Water hammer arresters.
4. Hose bibbs.
5. Hydrants.
6. Backflow preventers.
7. Pressure reducing valves.
8. Thermostatic water mixing valves.
9. Water tempering valves.

D. Certification: Submit certification that completed system complies with sterilization procedures and test requirements of municipality, State, and other public authorities having jurisdiction over system sterilization.

E. Submit copies of pressure test data of water systems to Owner prior to time of final completion of construction work.

F. Provide closeout documents as required in Section 23 00 00 - General Mechanical Provisions.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:
1. Codes, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.
2. Provisions specified in this Section.

B. Installer shall have been doing related work as described herein for a minimum of 5 years.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Piping Material:
1. Above Ground: Hard drawn copper, ASTM B88, Type “L”.
2. Below Grade (3” and smaller): Annealed copper, ASTM B88, Type “K” with no fittings allowed below slabs.

B. Fittings:
1. Solder joint pressure fittings: Wrought copper, ASME B16.22 or cast copper alloy, ASME B16.18.
2. Bronze flanges: ASME B16.24, Cass 150 with solder joint end. Furnish Class 300 flanges if required to match pipe.

C. Joining Method:
1. Solder: ASTM B32, Alloy Sn95, Sn94, or E; lead free.

D. Valves:
1. Gate Valves 2-1/2” and smaller: Class 125 for 200 psi cold working pressure or Class 150 for 300 psi cold working pressure, ASTM B62 cast bronze body and bonnet, solid bronze wedge, copper silicon alloy rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections, and aluminum or malleable iron handwheel.
2. Gate Valves 3” and larger: Class 125 for 200 psi cold working pressure, ASTM A126 cast iron body and bonnet, solid cast iron wedge, brass alloy stem, outside screw and yoke, teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections, and cast iron handwheel.
3. Install in main hot and cold water lines as indicated on Drawings.
4. Install at each branch take-off from main lines.
5. Install at each branch line serving hose bibbs, hydrants, etc.
6. Where shown on Drawings, in lieu of gate valves in water lines 2” and smaller, ball valves may be used at Contractor’s option: Class 150, 600 psi cold working pressure, ASTM B584 bronze body and bonnet, 2-piece construction, chrome plated brass ball, standard port for 1/2” valves and smaller and conventional port for 3/4” valves and larger, blowout proof, bronze or brass stem, teflon seats and seals, threaded or soldered end connections.

E. Strainers:
1. Strainers shall be Y-pattern with screwed screen retainer with centered blowdown and shall be full size of connecting pipe. Include ASTM A666, Type 304, stainless steel screens with 3/64 inch round perforations. Strainers shall be rated for minimum 125 psig steam working pressure.
2. Strainers 2” and smaller: Bronze body with female threaded ends.
3. Strainers 2-1/2” and larger: Cast iron body with interior AWWA C550 or FDA approved epoxy coating and flanged ends.

2.2 BACKFLOW PREVENTERS

A. Provide reduced pressure backflow preventers as indicated on the Drawings and as required by local authorities having jurisdiction. Backflow preventers shall be equal to Watts Series 909 reduced pressure principle type with isolation valves, removable bronze seats, ball type test cocks, bronze epoxy coated strainer, and an air gap fitting. Backflow preventer shall be selected for a maximum 7 psig pressure loss through middle one-third of flow range.

B. Provide double check valve assemblies where indicated on the drawings and as required by local authorities having jurisdiction. Double check assemblies shall be equal to Watts Series

709 with isolation valves. Assemblies 2" and smaller shall have bronze body construction with bronze strainer and ball type test cocks. Assemblies 2-1/2" and larger shall have FDA approved epoxy check and relief valves.

C. Provide drain piping connected to the air gap fitting to collect any discharge from the backflow preventer and pipe to the nearest drain.

2.3 AIR CHAMBERS AND WATER HAMMER ARRESTERS:

A. Air chambers shall be the same material and size as pipe branch or riser; minimum of 18" long.

B. Water hammer arresters shall be ASME A112.26.1M or PDI-WH 201, bellows or piston type with pressurized cushioning chamber. Sizes shall be based on water supply fixture units, ASME A112.26.1M and PDI-WH 201 sizes A through F. Units shall be P.D.I. (Plumbing Drainage Institute) certified, equal products by Sioux Chief.

C. Provide stainless steel access doors for access to water hammer arresters.

2.4 THERMOSTATIC WATER MIXING VALVES:

A. Provide ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body. Include check stop and union on hot and cold water supply inlets, bimetal thermostat with adjustable temperature setting rated for 125 psig minimum operating pressure.

B. Single Thermostatic Mixing Valve: Piping component finish shall be rough brass.

C. Manifolded Thermostatic Mixing Valve assemblies: Provide factory fabricated assembly consisting of thermostatic mixing valves arranged for parallel flow. Assembly shall include one large flow thermostatic mixing valve with flow control valve, pressure regulator, and inlet and outlet pressure gages and one small flow mixing valve with flow control valve. Include outlet thermometer and factory or field installed inlet and outlet valves.

2.5 WATER TEMPERING VALVES:

A. Provide manually adjustable, thermostatically controlled water tempering valve with bronze body and adjustable temperature setting rated for 125 psig minimum operating pressure.

B. Water tempering valves shall include a piston or discs controlling hot and cold water flow with anti-scald protection.

PART 3 - EXECUTION

3.1 PIPE AND FITTINGS

A. Securely anchor all water lines where directed. Provide expansion loops in hot water lines where necessary.

B. Install all hot and cold water lines with grade from high to low point. Provide drain valves at low point. Install free of air traps.

C. Valve Locations:
1. In main hot and cold water lines as indicated on drawings.
2. At each branch take-off from main lines: Valve location at mains; locate elsewhere as required.

D. Positive Shut-Off Valves: In each branch line serving hose bibbs, etc.: to expedite replacement or repair.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each service entrance pipe.

3.2 AIR CHAMBERS AND WATER HAMMER ARRESTERS

A. Install air chambers: At top of each riser serving a fixture; on each branch supply hot and cold water to a group of fixtures.

B. Install water hammer arrester at appliances and or fixtures having quick-closing valves.

3.3 HOSE BIBBS AND WALL HYDRANTS

A. Provide complete system as indicated: Provide a shut-off valve in each water supply line.

3.4 BACKFLOW PREVENTER AND PRESSURE REDUCING VALVE ASSEMBLY

A. Provide drain piping connected to the air gap fitting to collect any discharge from the backflow preventer and pipe to a drain.

3.5 FIELD QUALITY CONTROL

A. Testing:
   1. Furnish instruments, equipment, and labor necessary to conduct tests.
   2. Methods of sampling, inspecting, and testing shall conform to local codes.
   3. Tests of plumbing systems:
      a. Plumbing piping systems shall be pressure tested.
      b. Underground piping shall be tested and successfully repaired prior to backfilling.
   4. Water Systems:
      a. When rough-in is completed and before fixtures are set, entire hot and cold water and piping systems shall be tested at hydrostatic pressure of not less than 100 psig, and proved tight at this pressure for not less than 30 minutes.
      b. Where portion of water piping system is to be concealed before completion, portion shall be tested separately as specified for entire system.
   5. Defective Work:
      a. If inspection or test shows defects, defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated.
      b. Repairs to piping shall be made with new materials.
      c. No caulking of screwed joints or holes will be acceptable.

B. Disinfection:
   1. After pressure tests have been made and leaks repaired, flush entire domestic water distribution system with water until entrained dirt and mud have been removed.
   2. On the building side of each water meter assembly, provide a minimum 3/4 inch connection for injection of sterilizing fluid to disinfect the piping system chlorinating materials utilizing liquid chlorine or calcium hypochlorite shall be used.
   3. Provide dosage of not less than 50 parts per million.
   4. Retain treated water in pipe line enough to destroy all non spore forming bacteria.
   5. Retention time shall be at least 24 hours and shall produce not less than 10 ppm of chlorine at extreme end of system at end of retention period.
   6. Open and close valves in system being disinfected several times during contact period.
   7. Flush system with clean water until residual chlorine is reduced to less than 1.0 ppm, versus 0.2 at the most remote fixture.
   8. During flushing period, open and close valves and faucets several times at several locations.

9. From several points in system, take samples of water in properly disinfected containers for bacterial examination.
10. Repeat disinfecting until satisfactory bacteriological results have been obtained and City Health Department has made final approval of test.

3.6 ADJUSTING AND CLEANING

A. Equipment, pipes, and valves shall be cleaned of grease, metal cuttings, and sludge that may have accumulated from operation of system during test.

B. Stoppage, discoloration, or other damage to finish, furnishings, or parts of building, due to failure to properly clean piping system, shall be repaired.

C. When work is complete, adjust hot water systems for uniform circulation.

D. Adjust flush valves and automatic control devices for proper operation.

END OF SECTION

SECTION 22 13 00

FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide a complete sanitary waste and vent system as indicated herein and as illustrated on the Contract Drawings.

B. Make connections to fixtures and other devices as specified herein or as shown on the drawings.

C. Provide trap primer connections on floor drains or other devices as indicated and as required by local authorities having jurisdiction.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00 - General Mechanical Provisions.

B. Indicate on submittal piping material and joining method for each system and for the various sizes of piping systems to be installed. This shall be in tabular form in one location.

C. Product Data:
1. Pipe and fittings.
2. Joining methods.
3. Floor drains.
4. Clean outs.
5. Trap primers.

D. Certification: Submit certification that completed system complies with test requirements of municipality, state, and other public authorities having jurisdiction over system.

E. Provide closeout documents as required in Section 23 00 00 - General Mechanical Provisions.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in following order of precedence:
1. Codes, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction over installation, inspection, and testing, including local codes.
2. Provisions specified in this Section.

B. Installer shall have been doing related work as described herein for a minimum of 5 years.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Piping Material:
1. Cast Iron: Service and extra heavy classes. Include ASTM C564 rubber gasket for

each hub.

2. Copper: Type DWW hard drawn copper pipe.
3. Non-metallic: Schedule 40 PVC or ABS pipe and fittings may be used if allowed by local authorities having jurisdiction.

B. Fittings:

1. Hub and Spigot Cast Iron Pipe: Hub and spigot cast iron ASTM A74 service and extra heavy classes.
2. Hubless Cast Iron: CISPI 301 service weight.
3. Copper, Solder Joint Drainage Fittings: ASME B16.23 cast copper or ASME B16.29 wrought copper.
4. PVC or ABS Pipe: DWV, Schedule 40, Socket Type.

C. Joining Method:

1. Cast Iron Pipe:
   a. Pipes with hubs: Provide rubber or neoprene gasket seals, ASTM C564.
   b. Hubless Pipe: Provide stainless steel corrugated shield and clamp assembly over one piece neoprene sealing sleeve, CISPI 310.
2. Copper Pipe: ASTM B32, Alloy Sn95 or Sn94, or E non lead solder with non-corrosive paste-type flux.
3. PVC or ABS Pipe: Solvent cement.

2.2 TRAPS

A. Each fixture and piece of equipment requiring connection to the waste and sanitary drainage system, except a fixture with continuous waste shall be equipped with a trap which shall be provided under this contract. Provide deep seal traps on all floor drains.

2.3 CONDENSATE DRAIN PIPING

A. Condensate drain piping shall be Type "DWV" hard drawn copper pipe with cast or wrought copper drainage pattern fittings, or may be Schedule 40 galvanized steel piping with galvanized malleable iron drainage pattern threaded fittings. Schedule 40 PVC pipe and fittings may be used where allowed by local authorities having jursidiction.

2.4 TRAP PRIMER

A. Trap Primers shall be installed for all floor drains and shall be installed in walls beneath sinks or lavatories with gasketed access cover; Precision Plumbing Products, Inc. Model “Prime-Rite” P-1 or P-2 with distribution units.

2.5 CLEANOUTS

A. Floor Cleanouts; Josam No. 56000 series, "Leveleze", coated cast iron body with bronze plug, adjustable housing, scoriated secured round satin nickaloy top, vandal-proof screws and inside caulk connection. Size as indicated on plans.

B. Wall Cleanouts; Josam No. 58790 series, cast iron cleanout tee stainless steel wall access cover plate with center screw. Spigot connection size as indicated on plans.

C. Grade Cleanout; Josam No. 58850-5 series, round coated cast iron access frame, coated C.I. cleanout Ferrule and recessed ABS plug.

2.6 VENT CAPS

A. Josam No. 26700 series cast iron vandal-proof hooded vent cap with frost proof openings, counter flashing collar, deep protective hood and recessed securing screws. Provide vent cap on all vents through roof.

PART 3 - EXECUTION

3.1 SANITARY, WASTE, VENT PIPING AND FITTINGS

A. Sanitary Piping: Grade uniformly to the outside sewer connection with fittings and connections installed in accordance with the local plumbing code or ordinances. In no case shall the grade for horizontal piping be less than a uniform grade of 1/4" per foot for 3" piping and smaller, and not less than 1/8" per foot for 4" and larger pipe.

B. Vent Piping: Install as indicated on the plans with the vents extending and flashed through the roof. Piping shall be assembled and installed without undue strains and stresses. Make provisions for expansion, contraction, and building settlement or pipe movement. Terminate each vent with a vent cap.

C. Vent Sizing: Vents not sized on the Drawings shall be sized, collected, and terminated above the roof in accordance with the local plumbing code. In no case shall the pipe used be smaller than the sizes shown on the Drawings.

3.2 TRAPS

A. Trap Locations: Place as near to the fixture as possible. No fixture shall be double trapped.

B. Traps installed on threaded pipe shall be recess drainage pattern.

3.3 TRAP PRIMERS

A. Wherever possible, all trap primer lines shall be continuously sloped from distribution unit to either drain body connection or tailpipe. Location of trap primers shall be approved by the Architect on site prior to installation. Where possible, coordinate with Structural Engineer to cast continuous copper lines (no joints) in concrete floor.

3.4 CLEANOUTS

A. Cleanout Locations: Shall be provided in the base of each stack or inside leader and at each change in direction of the soil and waste piping. Distance between cleanouts in horizontal lines shall not exceed 50 feet. Distance between cleanouts on the exterior of the building shall be spaced no more than 90 feet. Cleanouts shall be installed in accessible locations approved by the Owner's Representative. Final locations of cleanouts shall be determined and approved on the job site by the Architect.

B. Cleanout Sizing: Cleanouts shall be of the same nominal size as the pipe with which they are installed up to 4" and 4" in size for larger piping.

C. Cleanouts in Walls or Floors of Finished Areas: Cleanouts shall be provided with heavy cast brass plug with countersunk head and stainless steel tops or access plates. Each access top or plate shall be factory engraved and embossed with approved letters or name of the service for which it is used and pipe material, if different from cast iron (i.e., PVC).

3.5 FLOOR DRAINS

A. Install in locations shown on the Drawings. Size as shown on the Drawings. Set top of floor drain strainer level with finished surface, unless otherwise noted.

END OF SECTION

SECTION 22 33 33

LIGHT-COMMERCIAL ELECTRIC WATER HEATERS

PART 1. GENERAL

1.1 RELATED REQUIREMENTS:

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 DESCRIPTION:

A. Water heater work is indicated on drawings, schedules and requirements of this section.

1.3 SUBMITTALS:

A. Submit product data including rated capacities of selected models, weights, furnished specialties, and accessories. Indicate dimensions, finishes and coatings, required clearances, and piping and wiring connections.

PART 2. PRODUCTS

2.1 WATER HEATER - STORAGE TYPE:

A. Provide storage water heater as scheduled, with welded steel tank, glass lining adjustable thermostat, fiberglass insulation and protective sheet metal jacket with baked enamel finish, magnesium anode, temperature and pressure relief valve.

B. Warranty - Submit a written warranty executed by the manufacturer agreeing to repair or replace water heaters and accessories that fail in materials or workmanship within the specified warranty period. The minimum warranty period shall be 3 years.

2.2 APPROVED MANUFACTURERS:

A. Approved Manufacturers: State Industries, A.O. Smith, Bradford White Corp. or PVI Industries, Inc..

PART 3. EXECUTION

3.1 INSTALLATION:

A. Install water heater where shown, according to equipment manufacturer’s written instructions, and with recognized industry practices, to ensure that water heaters comply with requirements of state and local codes.

B. Connect hot and cold water piping to water heater with shutoff valves and unions. Make connections with dielectric fittings where piping is made of dissimilar metals.

C. Flush water heaters upon completion of installation according to manufacturer’s instructions.

D. Install ASME temperature and pressure relief valves on storage tanks.

E. Pipe temperature and pressure relief valve discharge to nearest floor drain.

F. Install vacuum relief valves on cold water supplies.

D. Startup water heaters according to manufacturer's written procedures, upon completion of heater installation, and demonstrate compliance with requirements.
   1. Energize electric circuits.
   2. Adjust operating controls.
   3. Adjust hot-water outlet temperature settings.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 22 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. Provide items of plumbing related equipment and accessories as indicated and specified herein.

1.3 QUALITY ASSURANCE

A. Installer: Installer shall have a minimum of five years experience in installation of plumbing equipment of similar size and scope.

B. Codes and Standards: Standard Building Code; Standard Plumbing Code; and ASTM Standards.

1.4 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 23 00 00 - General Mechanical Provisions. Indicate construction materials, finishes, sizes, quantities, and related hardware equipment.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during installation shall be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 00 00 - General Mechanical Provisions.

1.6 COORDINATION

A. Manufacturer shall be responsible for details and dimensions not controlled by job conditions and shall show on his shop drawings required field measurements beyond his control. Coordinate with responsible trades to establish, verify, and maintain field dimensions and job conditions. Consult with other trades in advance and make provisions for their work to avoid cutting and patching.

PART 2 - PRODUCTS

2.1 CIRCULATING PUMPS

A. Hot Water Circulating Pump: Horizontal, in-line centrifugal, single stage rated for 125 psig minimum working pressure and 225 ºF water temperature. Provide with bronze casing and impeller, steel shaft with oil-lubricated copper sleeve, mechanical seal with carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket. The motor shall be non-overloading at any point on pump curve.

B. The motor shall be drip-proof, sleeve-bearing quiet-operating, rubber-mounted, construction with built-in thermal overload protectors.

C. Capacities shall be as noted on the Drawings. Equivalent pumps by Bell & Gosset, Armstrong, and Taco will be considered.

2.2 PLUMBING FIXTURES

A. All fixtures shall be new and of the best quality.

B. Plumbing fixtures shall be complete with required trim faucets, waste plugs, traps, supplies, stop valves, escutcheons, casings and necessary hangers, plates, brackets, anchors and supports. Vitreous China fixtures shall be first quality, with smooth glazed surfaces free from warp, cracks, discoloration or other imperfection Fixtures shall be white unless otherwise specified.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL

A. Provide competent foreman or supervisor for the installation of equipment and to counsel other trades in regard to connections and installation. Install equipment level and square in proper planes with other work, secure anchorage in place. Test operation, provide full instructions and demonstrate to the Owner's designated representative the proper methods of care, operations, and maintenance of the equipment.

3.2 EQUIPMENT INSTALLATION

A. Wall hung fixtures shall be rigidly supported by approved metal hangers, chair carriers, etc. concealed chair carriers shall have vertical members with foot supports bolted to the floor. Floor outlet fixtures shall be rigidly secured and bolted to the floor.

END OF SECTION

SECTION 23 00 00

GENERAL HVAC PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. The Work to be provided under this Division of Specification shall include the furnishing, delivering, unloading, handling, storing, erecting, adjusting and testing of all materials, apparatus and equipment required for complete, properly adjusted and operable mechanical systems for this project as shown on the drawings and in the Specifications. Provide all labor, equipment, tools and material necessary for the completion of this work.

1.2 CODES AND STANDARDS

A. The Codes and Standards of the following organizations shall generally apply where applicable and where no specific Codes and Standards have been cited. In the event of conflict between the Codes and Standards of these organizations, the more stringent shall govern.

AABC:	Associated Air Balance Council
ADC:	Air Diffuser Council
AMCA:	Air Moving and Conditioning Association
ANSI:	American National Standards Institute
ARI:	American Refrigeration Institute
ASA:	American Standard Association
ASHRAE:	American Society of Heating Refrigeration and Air Conditioning Engineers
ASME:	American Society of Mechanical Engineers
ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
FM:	Factory Mutual Engineering Company
IRI:	Industrial Risk Insurers
ISA:	Instrument Society of America
MSS:	Manufacturers Standardization Society
NBS:	National Bureau of Standards
NEC:	National Electric Code
NEMA:	National Electrical Manufacturer's Association
NFPA:	National Fire Protection Association
OSHA:	Occupation Safety and Health Administration
SMACNA:	Sheet Metal and Air Conditioning Contractors National Association
UL:	Underwriter's Laboratories, Inc.

B. All workmanship, material and equipment shall be in accordance with all local, state and federal codes.

1.3 ENGINEERING DRAWING

A. The accompanying plans show diagrammatically the sizes and location of the various equipment items and the sizes of the major interconnecting piping and ductwork, without showing exact details as to elevations, offsets, control lines, and other installation details. The Contractor shall carefully lay out his work to conform to the site conditions, to avoid obstructions and provide proper grading of lines. Exact locations of outlets, apparatus, and connections thereto shall be determined by reference to the accompanying Plans, to all detail drawings, equipment drawings, rough-in drawings, etc., by measurements at the building, and in cooperation with other contractors and subcontractors, and in all cases shall be subject to the approval of the Owners Representative. Minor relocations necessitated by the conditions at the site or directed by the Owners Representative shall be made without any additional cost to the Owner.

B. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted on the drawings.

C. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.

1.4 EQUIPMENT SIZES AND REQUIREMENTS

A. Space allocations in machinery spaces are based on equipment scheduled in each case. Should the Contractor offer equipment of another make that requires more space in any critical dimension, the Contractor shall submit, together with other submittal data on the equipment, prints of drawings indicating how the equipment may be installed, indicating room for servicing and revisions in piping or ducting and any other details necessary for the Owner's representative to form a judgment as to the suitability of the substitute material, as to performance, suitability for the space and other variables.

B. Duties of certain equipment items, horsepowers of driving motors and electrical characteristics are scheduled for equipment items of a particular make in each case. Should any substitute material be accepted which has other requirements that would involve allied equipment or the work of others, the Contractor shall be responsible for all modifications required at no change in contract price. As examples:

1. If an accepted A/C Unit has a brake horsepower requirement above the motor horsepower scheduled, the Contractor shall be responsible for providing a larger motor and heavier drive and any change in size of the protective device, conduit run and conductors serving that motor. The latter shall be extended through an individual branch protective device and branch circuit on through the panel, feeder, feeder protective device, etc.
2. If accepted heat exchangers, coils, etc. have greater pressure drops than those on which pumping heads were based, the Contractor shall be responsible for selecting proper pumps and drive and adjusting the electrical work as required.

C. Structural steel members are indicated to provide supports for certain specific sizes and weights of equipment. Should other equipment be offered, the spacing of the supports shall be varied to suit the equipment. Should the weight or size of a substituted item of equipment require additional supporting steel members, the Contractor shall be required to provide and install them at no change in contract price.

1.5 SUBMITTALS

A. Shop Drawings and Manufacturer's Data:

1. Submit manufacturer's data or shop drawings where required by a Section covering a particular system and/or piece of equipment. The manufacturer's data of shop drawings shall include but not be limited to giving full information as to dimensions, weight, materials, motor sizes, electrical characteristics, wiring diagrams, capacities and all information pertinent to adequacy of items.
2. Each submittal will be reviewed for compliance with general requirements of design and arrangement only; it is not a contract document and acknowledgement of compliance does not remove the Contractor of responsibility for performance of the work in compliance with all provisions and requirements of the Contract Documents. Job measurements and the coordination of all the dimensions for proper fit of all parts of the work and performance of all equipment supplies to meet specification requirements are and remain specific responsibilities of the Contractor.
3. The Shop Drawings are not intended to cover detailed quantitative lists of heating specialties, valves, air distribution devices, fixtures, and similar items. It is the Contractor's responsibility to procure the proper quantities required to comply with the established requirements.

4. Any Shop Drawings prepared to illustrate how equipment, piping, ducts, etc. can be fitted into available spaces will be examined under the assumption that the Contractor has verified all the conditions, and obtaining any approval thereon shall not relieve the Contractor of responsibility in the event the material cannot be installed as shown on those Drawings.
5. Any material or equipment installed without the Owner Representative's prior approval shall, if so directed by the Owner's Representative be removed and replaced with approved material or equipment at the Contractor's expense.
6. Any dimensional changes or rerouting of piping or ductwork shall necessitate submittal or shop drawings of the system under consideration prior to fabrication or erection of material. Drawings will be utilized by the Owner's Representative to evaluate the effect of the proposed changes on equipment performance.

B. Test Reports: The Contractor shall submit to the Owner's Representative all test reports in accordance with details specifically called for in the various Sections of the Specifications in this Division.

C. Operation and Maintenance Instructions:
1. Upon completion of work, provide three (3) sets of complete operations and maintenance instructions of mechanical equipment, neatly bound in 3 ring binders. Provide each binder with the name of Owner, Architect/Engineer, Contractor and Title. During the construction period, accumulate the following for inclusion in the Operating and Maintenance Manuals:
   a. All warranties and guarantees and manufacturer's directions on equipment and material covered by the Contractor.
   b. Approved fixture brochures, wiring diagrams, and control diagrams.
   c. Copies of approved Shop Drawings.
   d. Operating instructions for heating and cooling and other mechanical systems. Operating instructions shall include maintenance and seasonal changeover procedures.
   e. Recommended maintenance procedures.
   f. Repair parts list of all major items and equipment including name, address, and telephone number of local supplier or agent.
   g. Valve tag charts and diagrams specified elsewhere herein.
2. Operation and Maintenance instructions shall be submitted and approved prior to instruction of Owner's personnel in the various systems operation and maintenance.

1.6 RECORD DRAWINGS

A. As part of the required mechanical work, a complete set of record drawings shall be made up and delivered to the Owner's Representative. The drawings shall reflect the following:
1. All mechanical work installed exactly in accordance with the original design.
2. All mechanical work installed as a modification or addition to the original design.
3. The dimensional information necessary to delineate the exact location of all ductwork and piping runs which are so concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance. Where shop drawings have been prepared and approved, the record drawings shall be cross referenced to the respective shop drawings. In this case dimensions need not be shown on the record drawings.

B. Record drawings shall include the updating of all equipment schedules.

C. The record drawings shall be of a reproducible type as directed.

1.7 GUARANTEE

A. All materials and equipment, to be furnished and installed under this Division of the Specifications shall be guaranteed to meet the specified performance requirements and to be

free of defects in materials and workmanship for a period of one year after final acceptance. Deficiencies which show up and which are caused by other than normal usage shall be remedied by the Contractor to the complete satisfaction of the Owner's Representative, without cost to the Owner.

B. If there is any indication that the equipment does not meet the specified quantities, the Contractor shall, at his expense, institute a program to demonstrate the adequacy of the installation. This program shall include all necessary testing and testing equipment. Should the Contractor not have the equipment or technical skill to perform the tests, it shall be his responsibility to employ recognized experts to perform the tests and shall provide certified laboratory tests, certified factory reports and work sheets, or other certified data to support results of any tests required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise specified, provide only new, first grade equipment and materials which comply with requirements of this Specification and applicable Standards.

B. Furnish, if required, satisfactory evidence of kind and quality of materials proposed for use.

C. Similar items of material and equipment shall be product of same manufacturer.

2.2 SUBSTITUTIONS

A. Manufacturers' names are listed herein to establish a standard. The products of other manufacturers will be acceptable, if in the opinion of the Owner's Representative, the substitute material is of a quality as good or better than the material specified, and will serve with equal efficiency and dependability, the purpose for which the items specified were intended.

B. It is fully the Contractor's responsibility to assemble and submit sufficient technical information to fully illustrate that the material or equipment proposed for substitution is equal or superior as the Architect or Engineer is under no obligation to perform the service for the Contractor. The proposal shall be accompanied by manufacturers' complete engineering data, specification sheet, and a sample, if practical or if requested. In no event shall a proposal for substitution be cause for delay of work.

2.3 ELECTRICAL MOTORS

A. All motors furnished under any of the several sections of these specifications shall be of recognized manufacturer, of adequate capacity for the loads involved, and wound for the electrical characteristics indicated on the Drawings or specified herein. Verify all job site voltages and power source available before installation of any motor or controls. All motors shall conform to the standards of manufacture and performance of the National Electrical Manufacturers Association (NEMA) as shown in their latest publication. All motors shall be furnished with open-frame, unless otherwise noted, or required by NEC for the service conditions encountered.

B. Unless otherwise noted, fractional motors rated at less than 1/2 horsepower shall be single phase, the motors rated at 1/2 horsepower or larger shall be three phase. Single phase motors shall be arranged for across-the-line starting. Motors exposed to weather shall be totally enclosed and weatherproof. Single phase motors shall be capacitor start, induction run type and shall be furnished with motor controller with pilot light where scheduled or indicated.

C. Except as otherwise specified, open motors over one (1) horsepower shall be drip proof, squirrel cage, high efficiency type similar or equal to Reliance XE, Century E Plus III, Baldor Super E or General Electric Energy Saver, NEMA Design B, induction type rated for constant duty with 40 Deg. C. temperature rise. Furnish submittal data on all high efficiency motors furnished to include motor efficiencies as rated in accordance with IEEE Standard 112, Test Method B. Motors under one (1) horsepower shall be same as described herein, but standard efficiency rating.

D. All motors shall be of the same manufacturer unless they are an integral part of the piece of equipment to which they are attached.

2.4 MOTOR CONTROLLERS

A. Except where otherwise specified, each starter shall be furnished by the Contractor who furnishes the equipment it controls.

B. A manual or magnetic starter shall be provided for each motor. Where such devices are included in an "Equipment Control Schedule", they shall be as scheduled. Otherwise, they shall be as recommended by the equipment manufacturer.

C. Magnetic starters shall include overload protection for each phase wired with normally closed contacts in series control circuit ahead of any other control contacts on the control side of the solenoid coil and no contacts between the other side of the solenoid coil and the control power source. Motor starters shall conform to NEMA Standards for Industrial Control for 3 phase motors, No. 1C-1, with 120 volt (maximum) control circuit and control power transformer.

D. Where individual starters and disconnect switches (or circuit breakers) are indicated to be in the same location, furnish combination devices in a common housing. Fused disconnects shall have rejection type fuse clips and Class RK-1 fuses.

E. In every instance where magnetic starters are not required, furnish manual starters for fractional horsepower single phase motors - "On-Off", snap-switch type with soldered ratchet overload protection.

F. When interlocking or automatic control of single phase motors is indicated or required, the motors shall be furnished with magnetic across-the-line starters.

G. When interlocking or automatic control of electric heaters is indicated or required, the heaters shall be furnished with contactors. Provide control power transformers as required to maintain control circuit voltages not exceeding 120 volts.

H. Provide with each magnetic starter a reset button, pilot light and recovery HAND-OFF-AUTOMATIC switch, heavy-duty type, mounted in starter cover. Provide field reversible (normally open or normally closed) auxiliary contacts required for interlocking but in no case less than two (2) per starter.

I. Acceptable Manufacturers: Allen-Bradley, Cutler-Hammer, General Electric, ITE, Square D, Siemens.

2.5 SAFETY GUARDS

A. Provide safety guards for moving equipment such as fan belt drives and motor drive couplings.

B. Use OSHA approved belt guards and couplings guards. Provide 1/2 inch hole in guard at center of shaft of driven equipment where belt type drives are used.

2.6 IDENTIFICATION OF EQUIPMENT

A. Items of major mechanical equipment, including motor starters and switches, shall be permanently, neatly, and clearly identified with the same designations as appear on the Drawing.

B. Attach with heavy figure eight hooks onto the handle of each valve installed, a bronze disc not under one and one-half inch (1-1/2") diameter stamped with the prefix "P", "AC", or "F", followed by an identifying number not less than 1/2" high.

C. The number, location, and purpose corresponding to each valve shall be listed in sequence, properly typewritten on a schedule sheet to be turned over to the Owner.

D. Valve tags, identification mark-ups and schedule sheets shall be as manufactured by Seton Name Plate Company, New Haven, Conn.

E. Name plates shall be black bakelite with white engraved lettering, 1-1/2" x 4" with beveled edges and secured with epoxy cement and stainless steel screws. Provide larger plates to accommodate lengthy wording.

F. Pipe identification with fluid and flow arrows shall be provided with Seton Labels. Refer to Piping Identification, Section 15250, Insulation.

PART 3 - EXECUTION

3.1 PRODUCT HANDLING, RECEIVING, INSPECTION AND STORAGE

A. Handling and Receiving: The contractor shall receive and handle all materials and equipment with care so as not to cause damage. Use padded or strap slings, etc. as appropriate for the items being handled. Lift materials and equipment by lift points provided or recommended by the manufacturer.

B. Inspection: The contractor shall upon receipt, inspect all materials and equipment for defects, damage and compliance with the specifications. When materials and equipment are received in acceptable condition, assume full responsibility for its storage, handling and installation. Materials and equipment found to be incomplete or damaged shall be reported to the Carrier and Owner's Representative immediately, within a maximum of three (3) days, for its replacement.

C. Identification: Upon receipt of all materials and equipment, the Contractor shall identify and tag, stencil, or otherwise permanently identify all materials and equipment with the appropriate equipment number.

D. Storage: Materials and equipment, which cannot be installed immediately after delivery, shall be stored in a safe, dry location provided by the Contractor. Materials and equipment damaged or stolen while in storage shall be replaced by the Contractor at no cost to the Owner.

3.2 COORDINATION WITH OTHER CONTRACTORS AND OWNER

A. General: Cooperate to fullest extent with other Contractors and Owner to the end that all work shall be executed economically without delay and that it will not interfere with their operations.

B. Progress Schedule: Contractor shall inform himself of progress schedules of all other Contractors and shall work in accordance with schedules for completion of Contract.

C. Examine work of other trades which comes in contact with or is covered by this work. Do not attach to, cover, or finish against any defective work, or install work of this Division in a manner which will prevent other trades from properly installing their work. Consult all drawings, specifications and details of other Divisions of the work.

3.3 EQUIPMENT ACCESSORY REQUIREMENT

A. It shall be the Contractor's responsibility to assure all packaged equipment ancillary devices shall be completely wired, piped, tubed for pneumatics and calibrated. All systems shall be commissioned for acceptance by the Owner.

3.4 INSTALLATION

A. Materials and equipment installed under this Contract shall be new in every respect, and installed in a first-class manner in accordance with the manufacturer's recommendations and applicable codes and standards.

B. The Contractor shall plan and coordinate his Work to provide all equipment and materials necessary to provide the Owner with a neat, functional and serviceable installation.

C. The Contractor shall protect all work, materials and equipment against damage until Final Acceptance by the Owner. Replace, or repair to the satisfaction of the Owner's Representative, any work, materials or equipment that becomes damaged prior to Final Acceptance.

D. The Contractor shall make a detailed inspection of the work area and adjoining construction prior to beginning installation of any materials or equipment. Verify governing dimensions and other permissible dimensional tolerances. The Contractor shall report in writing to the Owner's Representative unsatisfactory conditions encountered; do not begin installation until conditions are correct. Beginning installation signifies acceptance of conditions.

3.5 CUTTING AND PATCHING

A. This Contractor shall do all necessary cutting and drilling of present walls, floor, ceilings, etc. for the installation of new work or for modifications to the existing work, but no structural work shall be cut unless specifically approved by the Owner's Representative. Patching and painting of surfaces as required shall be by the General Contractor, unless specified hereinafter.

B. Cutting and patching or repairing of work in place, made necessary by the negligence of the Contractor or anyone employed by him, shall be paid for by the Contractor.

3.6 CONNECTION OF EQUIPMENT FURNISHED BY OTHERS

A. All equipment furnished by the General Contractor, Electrical Contractor, or the Owner requiring service connections and/or ductwork shall be connected by this Contractor.

B. Materials and labor required for the connection of this equipment shall be furnished by this Contractor.

C. The respective supplier shall furnish proper roughing-in diagrams for the installation of these items. All items shall be roughed-in and connected in strict accordance therewith.

3.7 FINAL CONSTRUCTION REVIEW

A. Schedule: Upon completion of the Contract, there shall be a final construction review of the completed installation. Prior to this walk through, all work under this Division shall have been

completed, tested, balanced and adjusted in final operating condition and the test report shall have been submitted to and approved by the Owner's Representative.

B. Personnel: A qualified person representing the Contractor must be present at this final construction review to demonstrate the system and prove the performance of the equipment.

C. The building mechanical system shall have been in operation for a minimum of 15 days after Test and Balance work is complete prior to this review.

3.8 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these Specifications.

B. Certification is specifically required from the following:
1. Pressure test of all renovated and new pressure piping systems.
2. Equipment performance tests.

3.9 INSTRUCTION OF PERSONNEL

A. At completion of the Work, the Contractor shall furnish a competent service man to instruct the Owner's personnel in the proper operation and maintenance procedures to be followed. The instruction shall be given for a total of three (3) full working days, not including time spent trouble-shooting and adjusting the system as required by this Contract. At the Owner's option the instruction period may be postponed in part or in whole until a later period within the year following the completion of the Work.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. The following provisions generally define materials and methods to be used in fabrication, erection, and installation of piping systems and components. These provisions are in addition to the requirements included in the Piping Systems Sections and Drawings and are intended to supplement the Piping Systems Sections and Drawings. In case of conflict, the Piping Systems Sections and Drawings shall take precedence over this Section.

1.2 QUALITY ASSURANCE

A. General: Provide pipe, valves, fittings and specialties, unless otherwise specified, that are new, full weight, full length, scale-free and best quality of their respective kinds.

B. In addition to tests required for specific materials and systems, the manufacturer shall test or guarantee all materials to be as specified prior to delivery.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions.

B. Shop Drawings: Submit in accordance with Section 23 00 00 - General Mechanical Provisions.

1.4 PRODUCT HANDLING, DELIVERY AND STORAGE

A. Delivery, handling and storage of materials covered by this section shall conform to the requirements of Section 23 00 00 - General Mechanical Provisions.

B. Handling: Receive and handle all materials with care so as not to cause damage. Use padded or strap slings, etc. as appropriate for the materials being handled. Stainless steel shall not be allowed to contact carbon steel during handling, storage, or installation. Lift equipment by lift points provided or recommended by the manufacturer.

C. Delivery: Upon receipt, inspect all materials for defects and for compliance with specifications. Tag, stencil, or otherwise permanently identify all materials with particular care to adequately identify specialty items.

D. Storage: Properly store all pipe, piping materials, etc., so as to prevent deterioration while in storage. Store all materials off the ground or floor. Store inside or cover all materials subject to deterioration from weather. Store all stainless steel on wood. Remove all rust spots which appear on stainless steel by brushing (using a stainless steel brush), pickling, passivating.

E. Store loose materials such as fittings, gaskets, bolts, nuts, small valves, traps, and specialties in bins of sufficient number to provide proper separation. Protect the ends of large fittings, valves and pipe from the weather and abuse. Properly grease all machined surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Deviations from specified materials may be required due to availability. These deviations are permissible if they are equal to or better than the specified materials for the purpose for which used and if approved by the Owner's Representative.

B. Pipe and Tube:

1. Pipe and Tube Specifications: Provide pipe and tube of the material and dimensions specified in the service specifications.
2. In general, fittings used for the various piping systems shall be as listed below. Special fittings shall be used where required by job conditions and when approved for particular use.
    a. Welded Fittings: All fittings in welded lines shall be factory fabricated welding fittings of the same material and the same schedule or weight as the piping system in which installed. All elbows, reducers, tees, caps and special fittings shall be standard factory fabricated butt welding fittings, conforming to ANSI B16.9, with the following exceptions: Branch takeoffs from lines 2-1/2" in size and larger and where the size of the takeoff does not exceed two thirds of the nominal diameter of the mains to which connected may be made with shaped nipples or with Bonney Weldolets or Threadolets as required by the class of fabrication. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
    b. Screwed Fittings in Steel Lines: 150 lb. black malleable iron banded pattern screwed fittings. Unless otherwise specified, use TFE tape, 1/2 inch x 3 mil thickness, Scotch Brand or approved equal.
    c. Miscellaneous Fittings: Provide all reducers, increasers, adapters, bushings, etc., as required to properly interconnect the various items, to change sizes, etc. Steel fittings shall be used in steel lines, and copper and red brass fittings shall be used in copper lines.
3. The steel pipe shall be made and tested in accordance with the latest edition of "Standard Specifications for Welded Steel Pipe" of the National Tube Company, Youngstown Sheet and Tube Company, or other approved make. Unless otherwise specified, all pipe shall be Schedule 40 ASA Standard B36.10.
4. Fittings for copper tubing shall be Chase Sweat Fittings, Mueller Brass Company's "Streamline" solder fittings or approved equal. Drainage type fittings shall be used wherever possible. All solder for copper tubing shall be 95-5, Silfos or Eutectic No. 180F. All piping shall be installed in a workmanlike manner, according to the manufacturer's instructions. All joints shall be thoroughly cleaned before connecting. Silfos solder shall be required on all refrigerant piping joints.
5. Welding fittings shall be Tube-Turn, Taylor Forge, Ladish, or Midwest. Welding and fitting shall have the same bursting pressure as pipe of the same size and schedule. All elbows shall be long radius unless noted otherwise.

2.2 FLANGES

A. Flanges in welded lines shall be 150 pound forged steel, welding neck flanges, except where cast iron fittings are used as specified elsewhere in these specifications, and except as otherwise shown or required by conditions which might necessitate the use of slip-on welding neck flanges.

B. Flanges in screwed ferrous lines shall be 125 pound cast iron or 150 pound forged steel screwed flanges.

C. Where ferrous flanges connect to flat faced flanges on valves, items of equipment, etc., the companion flange shall be flush faced and where the flanges on items of equipment are raised face flanges, the companion flanges shall have raised faces.

D. Flanges in copper lines shall be solder joint type brass flanges.

E. Flange bolts and nuts shall conform to the applicable requirements of the latest edition of the Code for Pressure Piping.

2.3 GASKETS

A. Install gaskets between flanges of all flanged joints. Where used with brass or bronze flanges or with flat face ferrous flanges, they shall be full face type. For all other flanges they shall be ring gaskets properly cut to fit within the inside edges of the bolts.

B. Gaskets in water lines shall be Garlock No. 24 Wire Insertion Red Rubber Sheet Packing, 1/16" thick and for any other systems use special materials suitable for the duty as recommended by their manufacturer.

2.4 INSULATING FITTINGS

A. Except that no dielectric fitting shall be installed in connections between copper or brass and sanitary cast iron waste, drain and vent lines, wherever an interconnection is made between ferrous pipes or vessel and copper tubing or brass pipe, or vice versa, install a dielectric fitting.

B. In lines assembled with screwed or soldered joints, use insulating couplings (unions) suitable for the intended service and where flanged connections are required, use insulating gasket material between flange faces, insulating grommets between bolts and holes in flanges and insulating washers under both bolt heads and nuts.

C. PVC couplings of any kind shall not be acceptable for insulating couplings.

D. Insulating fittings shall be suitable for the service medium, operating pressure and temperature.

E. Insulating fittings shall be as manufactured by EPCO, Maloney, or Crane.

2.5 VALVES

A. All valves of any one type shall be of the same make throughout and insofar as practicable all valves in a given category shall be of the same make.

B. All valves shall be so located as to be readily accessible for operation and maintenance.

C. Furnish and install all valves indicated on the Plans, specified herein, or required to control the flow of water to and from various parts of the systems and to isolate various pieces of machinery and equipment and to isolate various parts of the systems.

D. Each valve for installation in a line to be insulated shall have sufficient clearance between the valve body and the operating handle or device to accommodate the insulation.

E. All valves which must be used during operation, all control valve assemblies, instrument control cases, liquid level controls, gage glasses, orifices, relief valves, and other equipment which must be observed, adjusted, or serviced during operation shall be located conveniently accessible from an operating platform or grade.

F. Frequently operated valves, on which the centerline of the stem is more than 7'-0" above the finished floor or platform levels, shall be provided with remote operating devices such as chain wheels or extension stems to permit ease or operation. Do not use chain wheels on screwed valves. Hang chains to within 3'-0" of the operating level and attach to columns or walls so as not to obstruct passageways. Provide frequently operated valves in trenches with extension stems extending to within 4" below cover plate if the hand wheels are more than 12" below cover plate.

G. Place manually operated valves, which are used in conjunction with locally mounted flow indicators, at same operating level and locate where the instrument can be readily observed.

H. Except where special valves are specified elsewhere herein or as required by special conditions or class of work, valves shall be equivalent to the following Crane Co. valve numbers:

1.

Type	Size	Crane Number
Gate	2" and smaller	428
Gate	2-1/2" and larger	465-1/2
Globe	2" and smaller	14-1/2 P
Globe	2-1/2" and larger	351
Angle	2" and smaller	16-1/2 P
Angle	2-1/2" and larger	353
Check	2" and smaller	37
Check	2-1/2" and larger	373

2. Valves shall be as manufactured by Crane, Stockham, or Nibco.

I. Where cocks are required, they shall generally be brass, screwed pattern up to 2" and cast iron flanged pattern 2-1/2" and larger plug cocks suitable for the system pressure. Also provide and install all special cocks required such as pet cocks, gauge cocks, etc.

J. Where plug valves are indicated, they shall be equal to that manufactured by DeZurik Corporation. These valves shall be flanged type (2-1/2" and larger) of semi-steel, with stainless steel bushings and shall have resilient plug facing with nickel alloy seat. Plug valves 4" and less may have bronze bushings. Furnish lever operator for all valves. Plug valves shall be bubble tight with 150 pound differential pressure across the seat. An indicator shall be included to show valve position. Plug valves shall be manufactured by DeZurik, W-K-M, or Rockwell Nordstrom.

K. Check valves in vertical water lines shall be similar to Combination Pump Valve Company Style G, Mission Valve Company "DuoCheck", Miller or Smolensky. Valves shall have nickel-iron body, bronze fitted with stainless steel spring. Valves shall be for 150 psig minimum cold working pressure.

L. Where shown on Plans, or in lieu of gate valves in water lines 2" and smaller, the Contractor may furnish ball valves. Ball valves shall be the equivalent of a Nibco T5954. Ball valves may also be used in lieu of plug valves for balancing purposes for lines 2" and smaller. Provide memory stops where used for balancing or as shown or detailed.

2.6 PIPE HANGERS

A. Pipe hangers (except fire protection) shall be Fee and Mason of a type suitable for each use. Perforated straps shall not be used in any work.

1. For ferrous pipes up to and including four inches (4") in size, use Fee and Mason Fig. 199 malleable iron, adjustable, split ring, swivel hanger.
2. Heating and air conditioning piping larger than four inches (4"), but not larger than twelve inches (12"), shall be Fee and Mason Fig. 170.
3. Where several pipes are parallel at the same elevation, trapeze hangers may be used. Where trapeze hangers are used, the pipes shall be supported on roller where rollers are called for by these specifications.
4. For copper pipes up to and including three inches (3") in size, use Fee and Mason Fig. 360 malleable iron, copper plated hangers. For copper pipes larger than three inches (3"), use Fee and Mason Fig. 364 copper-plated clevis hanger.

B. Hanger rod sizes shall conform to the following schedule:

Pipe up to 2"	3/8" rods
Pipe 2-1/2" to 3-1/2“	1/2" rods
Pipe 4" and 5"	5/8" rods
Pipe 6"	3/4" rods
Pipe 8", 10" and 12"	7/8" rods

C. Unless shown otherwise on the Plans, all horizontal runs of ferrous piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to 1-1/4"	8 feet
Pipe 1-1/2" and 2"	10 feet
Pipe 2-1/2" and 3"	12 feet
Pipe 3-1/2" and 4"	14 feet
Pipe 5" and 6"	16 feet
Pipe 8" and 10"	18 feet

D. Unless shown otherwise on the Plans, all horizontal runs of copper piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the following maximum spacing:

Pipe up to 3/4"	5 feet
Pipe 1" and 1-1/4"	6 feet
Pipe 1-1/2" and 2"	8 feet
Pipe 2-1/2" and larger	10 feet

E. Unless shown otherwise on the plans, all horizontal runs of CPVC piping shall be suspended from the floor or roof construction, as the case may be, by means of hangers with the flowing maximum spacing:

Pipe up to 1”	3 feet
Pipe 1-1/4” and larger	4 feet

F. There shall be a hanger within two feet (2') of each elbow or tee. Additional supports shall be provided for valves, strainers, etc. Cast iron pipe shall have not less than one hanger per length of pipe. Vertical risers shall be supported by approved riser clamps. Vertical pipes within a space shall have not less than two (2) supports.

G. Supports and hangers shall be installed to permit free expansion and contraction in the piping systems. Hangers shall permit vertical adjustment to maintain proper pitch. Where necessary to control expansion and contraction, the piping shall be guided and firmly anchored. No piping shall be self-supporting; nor shall it be supported from equipment connections.

H. Inserts shall be used where piping or equipment is to be hung from concrete construction. Inserts shall be Grinnell Fig. 281, wedge type, concrete inserts. All inserts shall be pretreated to prevent rusting. After the forms are removed, clip off all nails flush with the exposed surface of the inserts.

I. Expansion bolts shall be Ackerman-Johnson.

J. Beam clamps suitable for use with the type of steel construction involved shall be Fee and Mason Fig. 249 beam clamps, Fee and Mason Fig. 255 "C" clamps, Fee and Mason 285 side beam clamps, or Fee and Mason 252 or 253 adjustable beam clamps as required.

K. For insulated piping, hangers shall be sized to go around the insulation with saddles being provided to protect the insulation.

L. Spring Supports: Variable spring hangers may be used where vertical movement of piping is

less than 3/4", and where transfer of load to adjacent hangers or equipment is not critical. Variation of supporting effect for variable spring hangers shall not exceed 25% of calculated piping load through vertical travel. For systems having larger expansion and contractions, or where forces or moments on equipment connections must be limited, use constant support spring hangers. They must be carefully selected for specific application and calibrated for actual load. Equip spring hangers, whether variable or constant spring types, with load scales.

2.7 STRAINERS

A. Strainers shall be of the "Y" pattern type unless shown or specified otherwise. Ends shall be screwed or flanged to match the type of joints in the piping in which the strainers are installed. Each strainer shall have a 20 mesh, 0.033 opening, brass or monel screen. Where vertical space does not permit the installation of the "Y" strainer, install an equivalent basket strainer. Strainers for screwed piping shall be Sarco Type AT for steel piping or Sarco Type BT for copper piping; for flanged piping shall be Sarco Type D; or equivalent as manufactured by Grinnell, Crane, Lesley, McAlear, Keckley or Mueller.

B. During testing and cleaning of piping systems, use a fine mesh start-up strainer screen. After piping system is cleaned each strainer shall be taken apart, cleaned, and final strainer mesh shall be placed back in strainer for normal operating conditions.

2.8 GAUGES AND GAUGE COCKS

A. Provide the following pressure gauge cock connections:
1. At the suction and discharge of each pump.
2. At any other points indicated in the diagrams on the Drawings.

B. Where gauge connections are installed in insulated lines, install gauge cocks on a nipple of sufficient length that the cock handle will be free of the pipe insulation and position each cock in relation to surrounding piping and equipment so that the gauge may be easily read and so that a gauge having a 4-1/2" diameter dial can be screwed into and out of the cock. All gauge cocks shall be of the tee-handle type.

C. Install gauge cocks at pumps as close to pump suction and discharge connections as possible. Where drilled and tapped gauge connections are provided in the pump casing by the manufacturer, use these tappings.

D. Cocks shall be as manufactured by Crosby, Weksler, Marsh, or Trerice.

E. Furnish and install a pressure gauge suitably calibrated at each of the following locations:
1. The suction and discharge of each pump.
2. At other points indicated on the drawings.

F. Gauges shall be of the bourdon tube type, and shall be selected to operate at about the midpoint of their full range, i.e., for a 50 PSI operation, select a gauge of O to 100 psi. Each gauge shall be provided with a brass lever handle union cock. Cases shall be Phenol or Steel, not less than four and one-half inches (4-1/2") in diameter.

G. Pressure gauges shall be equal to Weksler "Regal" No. 900R with type ASD case, phosphor bronze with phosphor bronze brushed rotary movement and link; 4-1/2" dial, nickel plated ring, free standing cast aluminum case; equipped with micrometer adjustment pointer. Provide each gauge with scale range suitable for the duty.

H. Gauges shall be manufactured by Crosby, Weksler, Marsh, or Trerice.

2.9 THERMOMETERS AND THERMOMETER WELLS

A. Furnish and install brass or stainless steel closed separable thermometer wells for all thermometer and controller bulbs which are designed for liquid measurements. Whenever a thermometer or controller bulb is inserted in a pipe for either remote or local temperature indication or control, locate the thermometer well so that it will be completely surrounded by flowing fluid. Such thermometer locations as are shown on the Drawings are diagrammatic only. Install thermometer wells for maximum effectiveness and in the case of locally indicating instruments, for easy readability.

B. Supply each brass test well for use with the stem thermometers, a threaded brass plug and keeper chain. Install these test wells in the following locations such that they can be filled with oil to facilitate temperature measurements:
   1. At the inlet and outlet of each water heater or boiler.
   2. At other locations as specified herein or shown on the drawings.

C. Where thermometer wells are called for, furnish and install brass wells with the tip of the well extending into the water stream. The well shall have a plug attached to it with a short length of chain. The wells shall be installed in the vertical or at 45 degree angle up.

D. Thermometers shall be of the industrial mercury type with bronze enameled aluminum cases, glass fronts, 9" scales, separable sockets; straight or angle pattern so selected that they can be read from the floor. Straight type equal to Weksler Type 105 angle type equal to Weksler Type 115, Type 125, or Type 135, depending upon the angle and aspect. Furnish thermometers with 2-1/2" stem extensions where they are installed in insulated lines. Select scale ranges for maximum readability at the design temperature of the medium being measured.

E. Thermometers shall be installed at locations as specified herein or shown on the Drawings.

F. Thermometers and thermometer wells shall be as manufactured by Weksler, Trerice, or Taylor.

2.10 RELIEF VALVES

A. All closed water systems shall be protected with a relief valve. Valves shall be spring operated, all brass, and shall meet A.S.M.E. requirements for discharge capacities. Discharge lines shall be piped to the nearest floor drain. Relief valves shall be as manufactured by Watts, Klipfel, McAlear, or McDonnell and Miller.

2.11 AIR VENTS

A. Provide and install air vents where shown and at any high points or traps in water circulating lines where air might collect.

B. Each air vent shall be installed with a valve at its inlet and a valved bypass, and it shall discharge through a check valve. The waste lines from the valved bypass and the discharge check valve shall be collected and piped to the nearest floor drain in each case.

C. All automatic air vents shall have cast or ductile iron bodies with corrosion resistant bolts and stainless steel, Buna-N and brass internal control components.

D. Provide manual air vent cocks for all water coils where not integral or supplied with coil by manufacturer.

E. Automatic air vents shall be similar and equal to Hoffman No. 792, Armstrong No. AAE150 or Bell & Gossett No. 107.

2.12 DRAINS

A. Provide drain connections in all piping systems for freeze protection and for rapid draining of the system for maintenance work. Provide drains at the base of all risers.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship: Execute fabrication and installation in the best and most workmanlike manner by qualified, careful, and efficient mechanics in strict accordance with the Drawings and Specifications. When work is not being performed on pipe, including at the end of work each day, plug openings to prevent entry of foreign matter.

B. Routing: Piping Drawings are generally to scale but place piping, etc. by calculated dimensions rather than dimensions scaled from Drawings. Route piping by the shortest run consistent with good installation practice, clearance requirements, and expansion and flexibility provisions. Arrange piping to facilitate support of the piping and ease of removal for inspection or servicing. Keep maintenance areas clear of piping. Cut pipe and hang to align freely with flanges and fittings.

C. Welding:
1. Qualifications of Welders: Accomplish piping welding by a qualified welder or welding operator using a qualified welding procedure in accordance with ANSI B31.1. Welding procedure and welder qualification shall be in accordance with Section IX of ASME Boiler and Pressure Vessel Code except as modified by ANSI B31.1.
2. Certification of Welders: No certifications shall be more than two years old. Owner's Representative may accept or reject any certification. Any certification tests required will be conducted at a place and time convenient to both Contractor and Owner's Representative.
3. Carbon Steel: Weld carbon steel by one of the arc welding processes including, but not limited to the following:
   a. Manual shielded metal arc
   b. Manual shielded metal arc with Tig root pass
   c. Tungsten inert gas (Tig), or
   d. Metal inert gas (Mig)
4. Stainless Steel: Weld stainless steel by the Tig process with or without filler metal unless otherwise approved by Owner's Representative.
5. Seal Welding: Where seal welding of threaded joints is performed, entirely cover threads by the seal weld. Make up threaded joints to be seal welded without any thread compound. Make seal welds by a qualified welder.
6. Heat Treatment: Preheat and post heat treat welds, when required, in accordance with welding procedure.
7. Weld Repairs: Remove defects in weld requiring repair and make repair in accordance with ANSI B31.1. Drain piping with weld leaks during hydrostatic test to a level below the lead before weld repair. Release pressure in piping with weld leaks during pneumatic test before weld repair.

D. Brazing:
1. Provide brazing by a qualified brazer or brazing operator using a qualified brazing procedure in accordance with ANSI Code for Pressure Piping ANSI B31.1. Brazing procedure and brazer qualification shall be in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. The filler metal used in brazing shall be a non-ferrous metal or alloy having a melting point above 800 degrees F. and below that of the metal being joined. Composition of filler metal and flux shall be as recommended by manufacturer for metals being joined in accordance with approved procedure.

E. Soldering:

1. Soldering shall be similar to brazing above, except that solder alloy melts at a temperature below 800 degrees F. and procedure qualification is not required. Clean outside end of pipe and the inside cup of fitting with steel wool or sand cloth. Apply flux evenly but sparingly, until surfaces to be joined are completely covered. Flux to be non-corrosive paste type recommended by manufacturer for solder alloy being used. Remove all excess solder with a small brush while it is still in a plastic state but leave a filler around the cup of the fitting as it cools. Unless indicated otherwise, use solder alloys as follows:
   a. Alloy 95-5 (tin-antimony) for temperatures up to 250 degrees F. and pressures up to 150 psig for 4 inch and smaller.
   b. For temperatures above 150°F, braze joints as outlined above.

F. Fabrication
1. The location, direction, and size of all lines are generally indicated on the drawings. Branch connections in general are indicated and shall be so installed as to provide proper grades.
2. All lines shall be made up straight and true at proper grades. Condenser and condensate lines shall grade down to drains.
3. Piping shall follow as closely as possible the routes shown on the plans and take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.
4. Install piping to coils, pump and other equipment at full size indicated on drawings with size reductions installed at equipment.
5. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.
6. All headers shall be assembled as indicated using welding fittings throughout.
7. Screwed Threads: Clean cut screwed threads with no stripping, or burrs from cutting or threading, in accordance with ANSI B2.1. Dies shall be new, sharp, and properly designed for the piping material. Immediately before erecting the piping, thoroughly clean all threads on pipe and fittings of all cuttings, dirt, oil or other foreign matter. Liberally coat male threads with thread lubricant or TFE thread tape and make up piping sufficiently for the threads to seize. Use TFE tape on all stainless steel threaded joints. Do not mar or damage pipe and fitting surfaces. Do not use Permatex, lampwick, cork, wool, or any other similar material for thread sealant.
8. Dielectric couplings shall be installed where ferrous pipe joins copper lines and shall be rated for the intended medium pressure and temperature or service.
9. Unions: Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of systems. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items or coils, machinery items and other special pieces of apparatus. Unions in 2" and smaller lines shall be ground joint and unions 2-1/2" and larger shall be flanged unions. Unions shall be the same material and strength as other fittings in the lines. Companion flanges on lines at various items of equipment, machines, and pieces of apparatus shall serve as unions to permit removal of the particular item.
10. All piping shall be supported by hangers independently of equipment connections.
11. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
12. Swing joints or expansion loops shall be provided wherever shown on the drawings or wherever else necessary to allow for the expansion and contraction of piping. This shall be accomplished in an approved manner and this Contractor shall be responsible for any damage which may occur as a result of expansion and/or contraction of his piping.
13. Nipples shall be of the same size and of the same material as the piping in the system in which they are installed, except that "close", or "all thread" nipples shall not be used.

14. This Contractor shall keep all open ends of piping in each system plugged or capped to prevent dirt or other debris from entering the pipe at any and all times during construction and/or before fixtures or equipment is connected. All piping shall be flushed clear prior to connection to the central building systems.
15. The ends of all piping furnished and installed in all systems shall be thoroughly reamed to the full inside diameter of the respective pipe.
16. Exposed lines shall be run parallel with, or perpendicular to building lines and wherever possible shall be grouped together for easy service and identification. Whenever possible, horizontal and vertical runs shall be held as close as possible to the walls, ceilings, struts, members, etc., so as to occupy the minimum space consistent with the proper installation requirements for insulation, conduit, ductwork, lighting fixtures, etc., and the expansion requirements of each of these items and the building proper or the removal of the respective or adjacent pipes, conduits, and ductwork, and/or to allow for necessary access to valves, other pipes, conduits, dampers, etc.
17. Valves required for control or isolation of any part of the various systems shall be provided and shall be located in approved or accessible positions or made accessible through removable panels, etc., and where several valves are related as to function, they shall be grouped in a battery. This Contractor shall arrange with the General Contractor for proper location of all access panels required for valves, etc. subject to approval of the Owner's Representative.
18. Where new lines are indicated to connect into existing lines, careful coordination shall be exercised to determine exact elevations and locations of existing lines, to establish grades of interconnecting new lines, to establish procedures to interconnect lines, and to establish other details.

3.2 CROSS CONNECTION AND INTERCONNECTIONS

A. No plumbing fixtures, device, or piping shall be installed which will provide a cross connection or interconnection between a distributing water supply for drinking or domestic purposes and a polluted supply such as drainage system, or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water, or waste into the water supply system.

3.3 EXCAVATION AND BACKFILLING

A. Provide necessary excavating and backfilling for the installation of work specified in this Division. Refer to Soils Investigation and Geotechnical Report for additional requirements.

B. Trenches for underground piping and conduits shall be excavated to required depths with bell holes provided as necessary to insure uniform bearing. Care shall be taken not to excavate below depth, and any excavation below depth shall be refilled with sand or gravel firmly compacted. Where poor soil conditions are encountered, or where pipe is laid in a fill area, place and thoroughly compact a bed of 3/16" maximum size screened gravel in trench bottom to provide adequate support for piping. Where pipe is laid in rock trenches, bed in at least 6" of sand.

C. Alignment: Install piping to conform accurately to lines and grades shown on Drawings. Run utility lines perpendicular to curbs and building lines, unless otherwise shown or noted. Make all building connections through sleeves provided in walls or concrete floors. Where grades and slopes of gravity drain lines are not shown on Drawings, install 4 inch and larger drains at a uniform grade of not less than 1/8 inch per foot. Slope underground gravity drains smaller than 4 inch, 1/4 inch per foot, minimum.

D. Pipe Crossings: Lay lower pipe first and thoroughly compact backfill to level of higher pipe before higher pipe is laid. Maintain minimum clearance of 12 inches between pipes. Backfill material under such conditions shall be crushed stone, gravel or concrete as directed.

E. After the pipe has been installed, tested, and approved, the trenches shall be backfilled with

eight inches (8"), in each direction surrounding the pipe, of sand or gravel free of rocks, metal, or other foreign materials and to grade with approved material, well tamped or puddled compactly in place.

F. Do not proceed with back-fill operations until piping has been inspected by the Owner's Representative. Do not perform backfilling operations, except in the presence of the Owner's representative. This Contractor shall give the Owner's Representative 24 hours notice for such observation.

G. All piping outside the building shall be installed below the frost line. Where streets, sidewalks, etc., are disturbed, cut or damaged by this work, the expense of repairing same in a manner approved by the Owner's Representative shall be part of this contract.

H. Contractor shall bear sole responsibility for design and execution of acceptable trenching and shoring procedures, in accordance with State Law. On trench excavations in excess of five feet in depth, Contractor shall pay a qualified engineer to prepare detailed plans and specifications directing Contractor in the safe execution of trenching and shoring. It is understood that trench safety systems constitute a means and method of construction for which the Architect, Engineer, and Owner are not responsible. Accordingly, such documents when prepared, shall be separately issued by Contractor's Consultant, independent of project Contract Documents.

3.4 FLASHINGS

A. Flash around all pipes passing through the roof in connection with this contract, with sheet lead weighing not less than 4 lbs. to the square foot built a minimum of 10" into the roofing, in all directions from the outside of the pipe running up the pipe a minimum of 10" and more where vent terminals must be higher to conform to the requirements of the local Plumbing Code, and then turned over one inch (1") into the pipe cavity. All seams and joints shall be completely soldered closed and the entire flashing shall be completely waterproof.

B. Make all roof penetrations in accordance with the roofing system manufacturers approved methods.

3.5 PIPE INSULATION SADDLES

A. Provide a section of Foamglas insulation, calcium silicate, cellular glass or 7#/cu.ft. fiberglass insulation of thickness specified at hanger support locations and provide galvanized steel protection saddles at hanger locations. Saddle shall be half cylinders with hemmed edges.

B. Refer to Section 23 07 00, HVAC Insulation.

3.6 UNDERGROUND PIPING PROTECTION

A. The Mechanical Contractor shall protect the entire surface of all underground steel piping against rust and corrosion.

B. For piping not specified elsewhere to be furnished with factory applied pipe corrosion resistant wrapping, the piping surfaces shall be cleaned of rust, dirt, etc., with a wire brush and shall be free of oil and grease and completely dry.

C. Brush on, or otherwise apply as recommended by the manufacturers, a heavy full coating of TC Mastic (Tape Coat Company, Evanston, Illinois) or Reilly Protective Tar Enamel No. 3302 (Reilly Tar and Chemical Company, Indianapolis, Indiana). Dry coating shall be not less than twelve (12) mils thickness. Protect freshly covered surfaces with earth for at least 12 hours as recommended by the manufacturer and depending on the weather.

3.7 SLEEVES AND SHIELDS

A. Provide all pipe penetrations through walls, partitions, and slabs with sleeves large enough to adequately accommodate the pipe plus any insulation and thermal movement. In no case shall such sleeves be less than 1 inch larger than the outside diameter of the pipe or pipe insulation.

B. Install sleeves through the interior walls and partitions flush with standard surfaces; sleeves through outside walls to project 1/2" on each side of the finished wall and floor sleeves to project 3" above finished floors.

C. Set sleeves in place before pouring concrete or securely fasten and grout with cement. Set wall sleeves as wall is constructed. Where sleeves are inadvertently omitted from concrete floor or masonry walls, core drill sleeve unless use of jackhammer or other method is approved by Owner's Representative. For sleeves through interior walls, fill space between outside of pipe or insulation and inside of sleeve or framed opening with mineral wool or neoprene. For sleeves through exterior walls, pack with oakum, seal with link seal units.

D. Provide escutcheons and floor or ceiling plates on both sides of penetration through walls, floors, ceiling and partitions, whether or not insulated, for all pipes exposed to view in finished areas. Provide chrome plated brass escutcheons in finished areas.

E. Where lines above 170°F (77°C) pass through walls, partitions, floors, etc. constructed of combustible material, cover with at least 1-1/2" of insulation. Where hot lines pass through walls, partitions, floors, etc., provide a protective metal sleeve or thimble in walls, etc. Where they pass through firewalls, flash barricades, etc., adequately caulk space between pipe and sleeve with fireproof material or seal.

3.8 TESTING AND REPAIRING

A. Each Contractor shall, at his own expense, during the progress of the work or upon its completion, make such tests of his work as are herein specified, or as required by the Owner's Representative, or by State or Municipal Bureaus having jurisdiction and under their supervision.

B. The Contractor shall provide all apparatus, temporary piping connections, or any other requirements necessary for such tests. He shall take all due precautions to prevent damage to the building and its contents incurred by such tests as he will be required to repair and make good, at his own expense, any damage so caused. Testing of insulating piping shall be done before insulation is applied.

C. Perform any other tests as may be required by the Owner's Representative to indicate the fulfillment of the specifications.

D. Systems shall be tested in portions as required by the construction schedule and the portions being tested shall be effectively isolated and sealed off. When previously tested sections are connected into other sections, tests shall be re-run to include the new connections.

E. Partial systems shall be tested prior to connecting into existing lines.

F. Leaks in screwed joints shall be repaired by tightening the joint until the leak has stopped, or by remaking the joint if tightening fails to stop the leak. Leaks in welded joints shall be repaired by chipping out the weld around the leak and rewelding until it is stopped. Leaks in caulked joints shall be stopped by additional caulking of the joint, but, if that fails, the joint shall be re-made. A leak in a compression joint shall be repaired by remaking the joint using a new seal, compression ring, coupling, etc., as required. Leaks in soldered joints shall be repaired by remaking the joint and no soldering or brazing over existing joints will be permitted. Any defective piping shall be replaced.

G. Additional testing shall be as specified in the individual Sections of this Specification.

3.9 PAINTING

A. All apparatus furnished under this contract to be painted shall be thoroughly cleaned, rust scraped off, and all oil and grease scraped and washed off before any paint is applied.

B. Finished painting coats shall not be applied until this and other Contractors have completed their work in the area to a point that the finish painting will not be soiled or damaged. Drop cloths shall be spread where necessary to prevent oil or paint from defacing adjacent finishes.

C. All pipe covered with canvas glass cloth shall be sized and painted with two coats of enamel paint. All other uninsulated piping, hangers, ducts, supports, etc., to be painted shall have one coat of primer and be painted with two coats of alkyd enamel.

D. Items with factory applied enamel painting shall be protected during installation and other construction work. Damaged factory applied finishes shall be repainted by the Installing Contractor. Scratches to factory applied finish shall be sanded smooth before repainting.

E. All mechanical equipment to be painted shall be cleaned, smoothed, primed with one coat of primer, and painted with two coats of alkyd enamel. Care shall be taken in painting equipment not to cover, deface, or render illegible in any way, the name plates on the equipment or impair the operation or foul any moving parts of the equipment.

F. The Contractor shall paint in the manner specified all items installed which are exposed to view including in mechanical rooms. All pipe hangers, rods, supports, and inserts in furring or vertical pipe chases shall be painted with two coats of asphalt emulsion.

G. Concrete bases/foundations shall be painted with gray enamel.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART I - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General Requirements and referenced documents.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, tools, equipment, and service to test, adjust and balance all mechanical systems as indicated in accordance with provisions of Contract Documents.

B. Completely coordinate with work of all other trades.

C. The Mechanical Contractor's responsibilities for testing, adjusting, and balancing the mechanical systems are listed under "Services of Contractor."

1.3 QUALITY ASSURANCE

A. Agency qualifications: Independent test and balance (TAB) agency, certified by either the Associated Air Balance Council (AABC) or National Environmental Balance Bureau (NEBB).
   1. Work shall be supervised by registered mechanical engineer.
   2. Show at least five (5) successfully completed projects of similar size and scope.

B. Instrumentation: Instrumentation, type, quantity and accuracy shall be as described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification.

1.4 PROJECT CONDITIONS

A. The Owner will occupy the site and building during the entire testing, adjusting, and balancing period. TAB firm shall cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts and disruptions to Owner operations.

1.5 SERVICES OF CONTRACTOR

A. The Contractor shall have all systems complete and in operational readiness prior to notifying the TAB firm that the project is ready for testing, adjusting, and balancing.

B. As a part of this project contract, the Contractor shall make any changes in the sheaves, belts, motors, dampers, and valves or the addition of dampers and/or valves as required to correctly balance the air conditioning system as required by the TAB firm at no additional cost.

C. The Contractor shall provide and coordinate the services of qualified, responsible subcontractors, suppliers, and personnel as required to correct, repair, or replace any and all deficient items or conditions found during the testing, adjusting, and balancing.

D. In order that the air conditioning system may be properly tested, adjusted, and balanced, the Contractor shall operate the air conditioning system at his expense for the length of time necessary to properly verify its completion and readiness for TAB, and shall further operate and pay all costs of operation during the TAB period.

E. Project contract completion schedules shall provide adequate time frame allowances to permit the completion of TAB services prior to Owner occupancy.

F. The Contractor shall provide the TAB firm approved submittal data on all air conditioning equipment that has been installed and data regarding all changes that have occurred during construction so that the air conditioning system can be correctly tested, adjusted, and balanced.

G. The plans and specifications have indicated valves, dampers, and miscellaneous adjustment devices for the purpose of testing, adjusting, and balancing the air conditioning system to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm.

H. Verification that building construction status includes installation of all ceilings included in construction Contract, and permits the closing of all doors and windows to permit the obtaining of projected operating conditions.

I Air Distribution Systems:

1. Inspect installation and verify conformity to design; verify that supply, return, and exhaust ducts have been pressure-tested for leakage as recommended in the appropriate SMACNA Standards.
2. Verify that volume and fire dampers are properly located and functional, and that dampers serving requirements of minimum and maximum outside air, return air, and relief air provide tight closure and full opening, with smooth and free operation.
3. Verify that supply, return, exhaust, and transfer grilles, registers, diffusers are installed and operating properly.
4. Verify that air handling systems, units, and associated apparatus, such as heat exchangers, heating and cooling coils, filter sections, and access doors have been blanked and sealed to eliminate excessive by-pass around filters or coils or leakage of air.
5. Verify that exhaust fans are operating and are free from vibration, with proper fan rotation and belt tension; that heater elements in motor starters are of proper size and rating; provide records of amperage and voltage readings at each motor, and verification that they do not exceed nameplate ratings.
6. Check vibration isolation equipment for Specification compliance and for correct adjustment.

J. Water Circulating Systems:

1. Check and verify pump alignment and rotation.
2. Position all valves pertinent to system design and require operation to permit full flow of water through all system components. Operate hydronic systems under full flow conditions until circulating water is clean. All strainers shall be removed and cleaned as required during this cycle of operation.
3. Record each pump motor amperage and voltage. Readings shall not exceed nameplate rating.
4. Verify electric heater elements to be of proper size and rating.
5. All water circulating systems shall be full of water and free of air; expansion tanks set for proper water level; all air vents installed at high points of systems and operating freely.
6. Check and set operating temperatures of heat exchangers to design requirements.

K. Automatic Controls:

1. Verify that control components are installed in accordance with project requirements and are functioning as intended, including electrical power, control and interlock wiring, damper sequences, air and water resets, smoke detectors, and freeze protection thermostats.
2. Verify that controlling instruments are calibrated and set for intended operating

conditions, with the exception of room thermostats which shall be calibrated at the completion of the test and balance services.

1.6 SERVICES OF THE TESTING, ADJUSTING, AND BALANCING FIRM

A. Examine the Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing.

B. Inspect the installation of mechanical piping systems, sheet metal work, temperature controls and other component parts of the mechanical systems. The inspection of the work shall include that part relating to proper arrangement and adequate provisions for the testing and balancing.

C. Cut insulation, ducts, pipe and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish to their original or finished appearance.

D. Upon completion of the installation and start-up of the mechanical equipment, test, adjust, and balance system components to obtain optimum conditions in each conditioned space in the building. Mark equipment settings with permanent marker including damper-control positions, valve indicators, fan speed control levers, and similar controls and devices to show final settings.

E. Prepare and submit to the Architect complete reports covering the balance and operating conditions of each system.

F. Make not less than three (3) inspections within 90 days after occupancy of the building to verify that satisfactory conditions are being maintained throughout, and to report in writing any unusual conditions.

G. Make an inspection in the building during the opposite season from that in which the initial adjustments were made, and at that time make any necessary modifications to the initial adjustments required to produce optimum operation of the system components, to produce the proper conditions in each conditioned space.

H. The "TAB" firm shall be responsible for inspecting, adjusting, balancing, and logging the data on the performance of fans, dampers, air distribution devices, and the flow of water through coils.

I. During the balancing, the temperature control devices shall be adjusted for proper relationship between controlling instruments, and shall be calibrated by the Contractor using data submitted by the "TAB" firm. The correctness of the final settings shall be proved by taking and recording hourly readings for a period of three (3) successive 8-hour days, in a typical room on each separately controlled zone. The total variation shall not exceed 3 Deg. F. from the preset median temperature during the entire temperature survey period.

J. The air quantities indicated on the Drawings shall be balanced in accordance with industry-accepted procedures to within 10% of design airflow rates. The Contractor shall provide for the various fans and air conditioning units new replacement fan drives and motors as necessary to attain the scheduled air deliveries against the system characteristics encountered.

K. Before final acceptance is made, the "TAB" firm shall furnish to the Architect the following data in a 3-ring binder, tabulated and divided into sections by tested and balanced systems:
1. Summary of main supply, return, and exhaust duct pilot tube transverses and fan

settings indicating minimum values required to achieve specified air volumes.

2. Air quantities at each supply, return, relief and exhaust air handling device.
3. Air static pressure readings entering and leaving each supply fan, exhaust fan, filter, coil, balancing damper, and other component of each system. These readings shall be related to fan curves in terms of CFM handled.
4. Water flow rates, discharge pressures, suction pressures, operating head, full flow amps, no flow amps and calculated brake horsepower at each pump.
5. Motor current, rpm and brake horsepower readings at each equipment motor. List the voltages at the time of each reading.
6. The final report shall certify test methods and instrumentation used, final velocity readings obtained, air quantities at each inlet and outlet (supply, return and exhaust), temperatures, pressure drops, rpm of all equipment, amperage of all motors, air balancing problems encountered, and uncompleted "punch list" items. The test results shall be recorded on standard forms conforming to AABC and NEBB requirements.
7. The report shall include air flow schematic diagrams indicating and identifying test locations, such as duct transverse, outlet readings, pressure readings, and temperature readings, and shall be referenced to the recorded data on the forms.
8. A summary of design and actual operating conditions shall be included with each individual system outlining normal and ventilation cycles of operation. The final report shall provide a reference of actual operating conditions for the Owner's operating personnel.

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Refer to Section 23 00 00 for General Mechanical Provisions.

1.2 DESCRIPTION

A. This specification shall cover the furnishing of all materials, labor, equipment and accessories necessary for the installation of the insulation as herein specified. Insulation shall be installed in strict accordance with this specification, all applicable drawings, approved shop drawings and submittals and manufacturer's recommendations.

1.3 DEFINITIONS

A. For the purpose of this section of the specifications, the following definitions shall apply:

1. "Exposed Areas" shall be interpreted as piping and ductwork exposed to view within the building where function and appearance are considerations.
2. "Concealed Areas" shall be interpreted as areas within the building above finished ceilings or in chases where pipes and ductwork are not visible from the floor.
3. "Exterior Areas" shall be interpreted as areas outside the building which are exposed to weather above grade where function, appearance and weather protection are considerations.

1.4 QUALITY ASSURANCE

A. Notify in writing the Owner's Representative of the insulation schedule so that he may observe all insulation before it is concealed from view.

B. The Contractor is hereby forewarned that non-compliance of the specifications, substitution of materials without prior written approval, and failure to follow insulation material manufacturer's recommendations or approved submittals will result in disapproval of the insulation work.

C. Insulation shall be applied only by mechanics skilled in the trade and continuous supervision of the mechanics by a competent foremen is mandatory.

D. Certain kinds or quality of materials are specified. Approval by the Owner's Representative must be obtained for the particular items that the Contractor proposes to use before purchase orders are placed.

1.5 LIMITATIONS

A. Materials specified shall be applied subject to their temperature limits. Any methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.

1.6 FIRE RESISTANCE

A. Insulation, adhesive, sealer, vapor-barrier coatings and vapor-barrier materials shall have a flame-spread rating of not more than 25 and a smoke developed rating of not more that 50. Materials that are factory applied shall be tested as assembled and certified by the

manufacturer to meet standards. Materials which are field applied may be tested individually. No fugitive or corrosion treatments shall be employed to impart flame resistance.

1. Flame Spread and Smoke Developed Ratings: Shall be determined by Method of Test of Surface Burning Characteristics of Building Materials, NFPA No. 255, ASTM E84 and Underwriters' Laboratories, Inc. Building Materials List under heading "Hazard Classification (Fire)."

1.7 SUBMITTALS

A. Submit manufacturer's literature in accordance with the requirements of Section 23 00 00 for General Mechanical Provisions.

B. Submit manufacturer's data and literature of each insulation, cement, adhesive, sealer, mastic, vapor barrier, covering and cloth. The submittal data shall include but not be limited to the following:

1. Thickness of Insulation
2. Density
3. Maximum Temperature Limit
4. Fire and Smoke Hazard Ratings
5. Thermal Conductivity
6. Permeability of Insulation and Finishes
7. Moisture Absorption Data
8. External Facing Covering Type
9. Description of:
   a. Adhesives
   b. Mechanical Fastening System
   c. Application, Finishing and Flashing

1.8 GUARANTEE

A. Products and workmanship specified in this Section of the Specifications shall comply with the Guarantee Section of 23 - GENERAL HVAC PROVISIONS.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs define necessary characteristics of materials specified and possible sources. Materials by manufacturers other than those specified herein will be acceptable, provided such materials conform to the specified characteristics.

2.2 PIPING INSULATION

A. Class I insulation shall be heavy density preformed one-piece single seam insulation composed of fine inorganic glass fibers bonded together with a thermosetting resin with an all service jacket composed of white kraft paper bonded to aluminum foil and reinforced with glass fiber yarn, conforming to the following:

Maximum Temperature Limit, ºF	500
Density, lbs/cf	4.0 to 7.0
Specific Heat, BTU/lb/ºF	0.20
Thermal Conductivity, BTU/hr/sq.ft./ºF/in.	
at 75ºF	0.23
200ºF	0.26
400ºF	0.42
Jacket Water Vapor Permeability	0.02

B. Class II insulation shall be heavy density preformed one-piece single seam insulation composed of fine inorganic glass fibers bonded together with a paper bonded to aluminum foil reinforced with glass fiber yarn and factory applied pressure sensitive adhesive self sealing longitudinal overlap and end joints, conforming to the following:

Maximum Temperature Limit, °F	500
Density, lbs/cf	4.0 to 7.0
Thermal Conductivity, BTU/hr/sq.ft./°F/in.	
at 75°F	0.23
200 °F	0.26
400 °F	0.42
Jacket Water Vapor Permeability	0.02

C. Class III insulation shall be expanded closed-cell elastomeric, conforming to the following:

Maximum Temperature Limit, °F	-40 to 220
Density, lbs/cf	4.5 to 8.5
Combustibility	Self-Extinguishing
Thermal Conductivity, BTU/hr/sq.ft./°F/in.	
at 75°F mean temperature	0.27
90°F mean temperature	0.276
Water Vapor Permeability	0.08

D. Class IV insulation shall be formed hydrous calcium silicate, with mineral fiber reinforcing, with factory applied fire retardant jacket conforming to the following:

Maximum Temperature Limit,°F	1200
Density, lbs/cf	11 to 14
Combustibility	Noncombustible
Thermal Conductivity, BTU/hr/sq.ft./°F/in.	
at 200°F	0.43
400°F	0.48
600°F	0.58

E. Coatings, Sealers and Mastic

1. Mastic vapor barrier for low and medium temperature equipment and pipe insulation shall be white with perm rating not to exceed 0.02. Mastic vapor barrier for high temperature equipment and piping shall be a white mildew-resistant, fungi-resistant, vapor-resistant, weatherproof plastic resin (polyvinyl acetate, polyvinyl acrylic or copolymer) coating capable of adhering canvas or glass to calcium silicate or fiberglass.
2. Lagging and sizing adhesive for applying canvas and glass cloth to fibrous glass, polyurethane, mineral wool and calcium silicate insulation shall be white with a perm rating not to exceed 1.0 and shall have a temperature range of -20 to 180 degrees F.
3. Permanently flexible vapor barrier sealant for low and medium temperature applications shall be white with a perm rating not to exceed 0.01 and shall be suitable for temperatures to 300 degrees. Permanently flexible vapor barrier sealant for high temperature applications shall be black with a perm rating not to exceed 0.01 and shall have a maximum temperature limit of 500 degrees F.
4. Flexible elastomer sealer shall be an air drying contact adhesive for joining seams and butt joints of flexible elastomer insulation and shall have a temperature range of 0 to 220 degrees F.
5. High strength, neoprene contact adhesive for bonding low and medium temperature equipment and pipe insulations with reinforced foil faced kraft laps, glass fiber cloth, foils and laminated and film vapor barriers shall have a temperature range of -30 to 275 degrees F.

6. Sodium silicate base fibrous adhesive for bonding high temperature equipment and pipe calcium silicate insulation to non-porous surfaces shall have a temperature range of 40 to 850 degrees F.
7. Finish coating shall be a white, creamy odorless, non-toxic finish, resistant to most mild acids and alkalies, that provides a smooth, flexible, fire-resistive finish and shall have a temperature range of -20 to 180 degrees F.

F. Fiber-Glass Cloth shall be a high-strength, fiber-glass cloth, 0.03 inch thick, 5.8 ounces per square yard with an open weave for complete penetration of mastic.

G. Factory-fabricated aluminum jackets shall be constructed of smooth T-3003 alloy in a minimum thickness of 0.016 inches with an integrally bonded moisture barrier consisting of one layer of one mil polyethylene film with #40 virgin kraft paper over the entire surface in contact with insulation. The jacketing shall be fabricated with continuous modified Cellular Z-Lock on the longitudinal seam requiring no screws, rivets or bands for installation and each section shall not be greater than three foot (3'-0") in length. Fittings shall be covered with two piece 0.028 or 0.024 inch thick stamped fitting covers. Butt straps shall be constructed of aluminum, two inches (2") wide and shall contain a high temperature sealant.

H. Fitting covers shall be premolded or fabricated from segments of the same material and thickness as the pipe covering with a matching vaporproof barrier. Fitting covers consisting of one-piece, pre-molded high impact PVC with fiberglass inserts may be provided if approved by governing authorities. Fitting covers shall be used for elbows, tees, valves, end caps, mechanical line couplings, and specialty fittings.

2.3 DUCT INSULATION

A. Class A insulation shall be foil faced flexible fiberglass duct wrap with heavy duty jacket composed of 4 mil thick laminate of aluminum foil, glass reinforcing scrim and kraft paper conforming to the following:

Maximum Temperature Limit, °F	200
Density, lbs/cf	1.0 to 1.5
Thermal Conductivity, BTU/Hr/°F/sq. ft.	0.24

B. Class B duct liner shall be semi-rigid, multiple density, one piece fiberglass thermal and acoustical liner with fire and abrasion resistant black coating to preclude air erosion up to 4000 FPM velocity, conforming to the following:

Maximum Temperature Limit, °F	250
Density, lbs/cf	1.5 to 2.0
Thermal Conductivity, BTU/Hr/°F/sq. ft.	0.24

C. Class C insulation shall be foil faced fiberglass sheet furnished in board form conforming to the following:

Maximum Temperature Limit, °F	250
Density, lbs/cf	3 to 10
Thermal Conductivity, BTU/Hr/°F/Sq. Ft.	0.23

PART 3 - EXECUTION

3.1 GENERAL

A. Before any insulation is applied, all piping shall be thoroughly cleaned, tested and made tight. All systems requiring a hydrostatic or pneumatic test shall have the test completed and approved by the Owner's Representative before the insulation is applied. Insulation shall be

applied to pipe surfaces only when these surfaces are clean and completely dry. Any insulation that is wet from condensation, rain or other source shall be removed and new insulation installed.

B. All insulation shall be installed according to the manufacturer's recommendations, and workmanship shall be first-class in every respect. Joints shall be tightly butted, and the covering shall be applied tight and smooth, the insulation shall be cut and fitted neatly around irregular surfaces and the insulation materials securely attached to the pipe. Jacket seams shall be cut with a sharp knife or scissors, not ripped, and the seam applied to the least conspicuous side where finish coats of sealer, vapor barrier or other fluid materials are sprayed, painted or troweled on, these coats shall be applied to the full thickness specified and shall be uniform without ridges, pigtails, bubbles or holidays.

C. Adhesives, sealers, vapor barrier coatings, etc., shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state.

D. Insulation shall be neatly finished at pipe hangers. All cold pipes or pipe insulation which is totally vapor sealed shall have pipe hangers on the outside of the insulation and hangers shall be equipped with insulation shields. Metal jacketed pipes shall have hangers or supports equipped with metal saddles of the same material as the jacket. Pipe insulation shall be continuous through walls, floors, ceiling openings, hangers, supports and sleeves.

E. Provide vertical pipe lines with sheet metal insulation supports at intervals not to exceed 15 feet. Supports shall be T304SS (type 304 Stainless Steel). Whether inside or outside, flash all penetrations of insulation with metal and/or waterproof sealing compound so that water cannot stand or enter from above. On horizontal lines, longitudinal seams of metal jackets shall be sealed to drain and jacket laps, if any shall also be installed to drain. Flash insulation terminations and seal with care to keep liquid out.

F. Flange Covers at Equipment: Provide removable type covers on flange fittings between equipment and piping. Fabricate a frame made in two half sections of 1" hex, monel mesh x 0.032" three twist monel wire to which block or sectional insulation is attached. Flange cover shall extend 2" over ends of adjacent pipe insulation with the ends of the pipe insulation terminated, beveled and finished as specified. After the frame is insulated, the inside and outside shall be finished with insulation cement same as for Class of insulations used on piping service. The two half sections of removable flange covers shall be held in place with 1/2" x 0.020" thick stainless steel bands (2 minimum per cover) after the specified finish has been applied to insulation.

G. Application Temperature: No insulation shall be applied or cured in ambient temperatures below 40°F. Insulation applied or cured in ambient temperatures below 40°F. shall be removed and replaced by the Contractor at no expense to the Owner.

H. Modifications to Existing Insulation: Where existing insulation is disturbed or damaged during the process of installing other new materials, making new connections, etc., it shall be repaired or replaced to return it to its original condition and appearance. Where existing lines are removed and connections to insulated lines are capped, insulate those caps as well as repairing damaged insulation. Materials shall match those presently installed in thickness, density, insulating value, jacketing, etc.

I. Shields: Metal saddles shall be applied between hangers or supports and the pipe insulation. Saddles shall be formed to fit the insulation and shall extend up to the centerline of the pipe and shall be of the length specified herein. Shields shall be made of galvanized sheet metal and shall be of sufficient size and length to prohibit the crushing of the insulation materials. Saddle shields shall be as follows:

METAL SADDLES

PIPE SIZE	METAL GAUGE	LENGTH
1/2" to 3"	16	12"
4" to 10"	12	16"
12" & larger	10	18"

J. Inserts: Provide inserts of calcium silicate on hot piping and cellular glass or 7#Cu.Ft. fiber glass pipe insulation on cold piping at hangers. Inserts between the pipe and pipe hangers shall consist of rigid pipe insulation of a thickness equal to the adjoining insulation and shall be provided with vapor barrier where required. Insulation inserts shall not be less than the following lengths:

PIPE SIZE	INSERT LENGTH
1/2" to 3"	12"
4" to 10"	16"
12" & larger	18"

K. Material Changes: Wherever there is a change in materials on lines that are vapor sealed, apply a suitable adhesive that is compatible with both materials, tapes, etc., as required to maintain the vapor barrier.

3.2 PIPING INSULATION APPLICATION

A. Class I Insulation Application:
1. Class I insulation with integral jacket shall be applied to piping systems with joints firmly butted together and jacket longitudinal flap on top for horizontal pipe and on the least conspicuous side of vertical pipe. Apply a brush coat of mastic vapor barrier on both contact surfaces, the overlapping jacket flap and the insulation jacket. At butt joints, apply brush coat of mastic vapor barrier on both the pipe insulation jacket and the butt strips. Butt strips shall be a minimum of four inches (4") wide and of the same material as the insulation jacket. Apply vapor barrier sealant to cover all overlapping jacket flap seams and butt strip seams.
2. Fittings, valves, flanges, unions, and strainers shall be completely covered with pre-molded fiberglass insulation or fabricated metered sections of the same thickness and density as the adjoining pipe covering. Smooth and level the insulation with mastic vapor barrier and seal all seam edges. The circumferential edges shall be wrapped with butt strips, minimum of four inches (4") wide, with mastic vapor barrier applied to the entire inside surface and the outside surface seams. All valve stems and operators and strainer clean-out covers shall be left exposed for normal operations.
3. In exposed areas the insulation shall be additionally finished with a skim coat of insulating cement over which a wrapping of open mesh glass cloth shall be embedded between two (2) uniform flood coats of lagging.
4. In exterior areas the entire insulation jacket shall be coated with vapor barrier sealant and covered with an aluminum jacket. All fittings, tees, elbows, valves, etc. shall be covered with factory fabricated aluminum fitting covers. All aluminum jacket seams and joint butt straps shall be coated with vapor barrier sealant.

B. Class II Insulation Application:
1. Class II insulation with integral jacket and self-sealing overlapping jacket flap shall be applied to piping systems with joints firmly butted together and jacket longitudinal flap on top for horizontal pipe and on the least conspicuous side of vertical pipe. Seal longitudinal overlapping jacket flap from the middle outward by pulling the flap tight. At butt joints, apply self-sealing butt strips tight around the butt joints. Butt strips shall be a minimum of four inches (4") wide and of the same material as the insulation jacket.

2. In exposed areas the insulation shall have a smoothing finish coating applied to the entire insulation jacket.
3. In exterior areas the insulated pipe system including elbows, fittings, valves, unions, etc., shall be covered with an aluminum jacket.
4. Fittings, valves, flanges, unions, and strainers shall be completely covered with pre-molded fiber glass insulation or fabricated metered sections of the same thickness and density as the adjoining pipe covering. Smooth and level the insulation with moisture vapor barrier and seal all seam edges. The circumferential edges shall be wrapped tight with self-sealing butt strips, a minimum of four inches (4") wide. All valve stems and operators and strainer clean-out covers shall be left exposed for normal operations.

C. Class III Insulation Application:
1. Class III Insulation shall be applied to piping systems by slipping unsplit insulation on pipe prior to connection wherever possible to avoid seams in insulation material. Open ends of pipe shall be capped or plugged before insulation is slipped on pipe. Thoroughly seal butt joints in insulation with adhesive. Where slip-on technique is not possible, split tubular insulation longitudinally in a straight line and apply around pipe, and thoroughly seal longitudinal seams and butt joints with adhesive.
2. Fabricate and install fitting cover insulation according to manufacturer's recommended procedures. Insulate sweat fittings with mitercut pieces of insulation the same size as adjoining piping. Seal metered joints and seams of insulation with adhesive.
3. Provide rigid pipe insulation on all piping at pipe hanger locations. Protect rigid insulation with 26 gauge galvanized steel pipe saddles installed between each hanger and the rigid insulation. Each saddle shall be a minimum of 3" wide and formed to fit curvature of insulation surface. Seal all joints between normal and rigid insulation with adhesive.
4. Following the installation of the adhesive, thoroughly dry and clean all surfaces of insulation with a non-oily solvent. After the insulation is dry, apply two (2) coats of Armaflex Finish in the manner recommended by the manufacturer.

D. Class IV Insulation Application:
1. Class IV insulation shall be applied to piping systems, boiler stacks and flues with curved segments or flat sheets secured with galvanized 14 gauge steel wire, followed by 1/2-inch of hydraulic-setting insulating and finishing cement trowelled on. After the first coating is dry, a layer of 20 gauge galvanized wire mesh, 1-inch hexagonal shall be installed, followed by 1/2-inch trowel coat of hard finish insulating cement. When dry, apply a flooding coat of mildew-resistant, fungus-resistant, weather-resistant resin mastic, in which a wrapping of open mesh glass cloth shall be embedded. Apply a finish coat of mastic to make a smooth outer surface.

3.3 DUCT INSULATION APPLICATION

A. Class A Insulation Application:
1. Flexible fiberglass insulation shall be wrapped around ducts and secured with outward-clinching staples. Ducts 24 inches wide and larger shall have the insulation additionally secured with stick clips on 18-inch centers. Insulation shall be lapped a minimum of four inches. All longitudinal and transverse joints, seams and connections of supply and return ducts operating at a static pressure less than or equal to 2 inches w.g. (500 Pa) shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems or tapes. Pressure sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with the certification. Where insulation terminates, raw glass shall be sealed to duct.
2. Exterior duct shall be protected with .016 inch thick aluminum jacket with overlap seam on bottom of duct. Aluminum jacket shall be overlapped a minimum of 2

inches and edges shall be sealed with silicone sealant. Seams at bottom of duct shall have silicone sealant applied between flaps and shall be screwed closed with sheet metal screws at maximum 6 inches O.C.

B. Class B Duct Liner Application:

1. Apply liner in accordance with manufacturer's and SMACNA recommendations with the heavy density side or facing side to the air stream, overlapped in direction of air flow, and adhere with 100 percent coverage of UL listed fire retardant adhesive, coating exposed leading edges, transverse and longitudinal joints. Transverse joints shall be neatly butted and there shall be no interruptions or gaps.
2. For velocities to 2000 feet per minute: Fasteners shall start within 3 inches of the upstream transverse edges of the liner and 3 inches from the longitudinal joints and shall be spaced at a maximum of 12 inches O.C. around the perimeter of the duct, and a maximum of 12 inches from a corner break. Elsewhere they shall be a maximum of 18 inches O.C., except that they shall be placed not more than 6 inches from a longitudinal joint of the liner nor 12 inches from a corner break. Clips shall be pointed up to maintain the sealing properties at the adhesive.
3. For velocities from 2,001 to 4,000 feet per minute: Fasteners shall start within 3 inches from the longitudinal joints and shall be spaced at a maximum of 6 inches O.C. around the perimeter of the duct, and a maximum of 6 inches from a corner break. Elsewhere they shall be a maximum of 16 inches O.C., except that they shall be placed not more than 6 inches from a longitudinal joint of the liner and no more than 12 inches from a corner break. Metal nosings shall be installed to secure leading edge of liner at upstream traverse edges, where required by SMACNA or manufacturers instructions. Clips shall be pointed up to maintain the sealing properties of the adhesive.
4. Provide insulated "build-out" sections to maintain the continuity of the thermal barrier when specialties, such as dampers and turning vanes, are secured to the sides of the duct. Build-outs shall be secured to the duct with sheet metal screws, bolts or welds.
5. Provide sheet metal internal transition fitting on leading edge of ductwork connections to equipment, flexible connections, or unlined duct. Transition shall afford smooth air flow into lined duct, with no more than 45 degree break angle, and overlap leading edge of lining at least 1-1/2 inches.
6. Provide 1/2 inch mesh, 24 gauge, galvanized steel metal lath inner liner, secured with mechanical fasteners, on ducts with air velocity greater than 4000 FPM or as indicated on drawings. Inner liner shall be used to compress insulation thickness to 75 percent uncompressed value.

C. Class C Insulation Application:

1. Fiberglass board insulation shall be applied to ducts with mechanical fasteners such as stick-clips or weld-pins spaced as required to install full pieces of board insulation, and spaced on 12-inch centers (maximum) on the bottom of each duct and plenum. Joints and seams in vapor barrier facings shall be covered with 3-inch wide matching tape, or with vapor-barrier mastic reinforced with 3-inch glass mesh reinforcement. Where duct standing seams exceed the insulation thickness, an additional layer of insulation board shall be provided.
2. Provide access door insulation so that doors can be opened without damaging insulation.
3. Insulated ducts penetrating walls or floors shall be insulated completely through penetration. Provide waterproof calcium silicate insert, same thickness and jacketing as insulation, with wall flange for fire wall or floor penetrations.

3.4 PIPING IDENTIFICATION

A. Furnish piping identification markers for all insulated piping systems in sizes and colors in accordance with ANSI A13.1. Markers shall be as manufactured by Seton Name Plate

Corporation, EMED or Craftmark equal to their roll form markers with pressure sensitive arrows on a roll securing both ends of marker wrapped completely around pipe.

B. Provide flow arrows at each marker location.

C. Markers shall be spaced not more than 20 feet on center and at each change of direction not more than 4 feet from each elbow.

D. Apply markers only after insulation system is complete to include aluminum jacketing as applicable and sizing and painting of canvas jacketing as applicable. Apply adhesive to area where markers are to be installed.

3.5 INSULATION SCHEDULE

A. Piping:

Insulation Service	Insulation Class	Thickness
Condensate Drain Piping	III	3/4"
Chilled Water Supply and Return Piping		
Up to 1-1/2" diameter	I	1"
Over 1-1/2" diameter	I	1-1/2"
Heating Water Supply and Return Piping		
Up to 1-1/2" diameter	II	1"
Over 1-1/2" diameter	II	2"

B. Ductwork:

Insulation Service	Insulation Class	Thickness
Supply Air Duct	A	2"
Return Air Duct	A	2"
Outside Air Duct	A	2"
Exposed Supply Air Duct	B	2"
Exposed Return Air Duct	B	2"
Exterior Supply Air Duct	C	2"
Exterior Return Air Duct	C	2"
Supply Air Duct within Mechanical Rooms and within 10 feet of Fans	B	1.5"
Return Air Duct within Mechanical Rooms and Return Air Plenums	B	1.5"

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Refer to Section 23 00 00 for General Mechanical Provisions.

1.2 SYSTEM DESCRIPTION

A. Natural gas piping at pressure up to 15 psig.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Conform with the applicable codes and standards listed in Section 23 00 00 - GENERAL HVAC PROVISIONS.

1.4 SUBMITTALS

A. Submit manufacturer's literature, engineering data and shop drawings under provisions of Section 23 00 00.

1.5 PRODUCT HANDLING, DELIVERY AND STORAGE

A. Storage and protection of materials shall be in accordance with Section 23 00 00.

1.6 GUARANTEE

A. Products and workmanship specified in this section of the specification shall comply with the Guarantee requirements of Section 23 00 00 - GENERAL HVAC PROVISIONS.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. All changes in size and direction shall be made with fittings.
2. Miter fittings, face or flush bushings, close nipples and street elbows are not acceptable.
3. All branch connections shall be made with tees.

B. Underground Piping:
1. Pipe: Polyethylene (PE) pressure pipe and tubing, and piping fittings, PE 2306.
2. Fittings: Butt fusion joints. All elbows long radius. Joints between transition fittings, compression couplings.
3. Valves: Plug valve 150# cast steel, lubricated, gland type, flanged ANSI B16.5, wrench operated. Nordstrom Fig. 1925 or equal.

C. Aboveground Piping:
1. 2" and Smaller:
   a. Pipe: Schedule 40, carbon steel, ASTM A53, Grade B seamless or electric resistance welded ends threaded and coupled.
   b. Fittings: 150 pound class, ASTM A47, Grade 32510, black malleable iron, screwed. ASME B16.3

c. Unions: 150 pound class, ASTM A47 Grade 32510, black malleable iron, screwed ground joint, bronze to iron seat. ASME B1.20.1 NPS thread.
d. Thread TFE tape 1/2" wide x 3 mil thickness, Scotch brand or approved equal.
e. Strainers: 125 pound S.W.P., screwed, cast iron body, "Y" pattern, stainless steel screens with 3/64-inch perforations.
f. Plug: 150 pound cast steel, screwed gland type, wrench operated, Valves: lubricated, screwed ends. ANSI B2.1 Nordstrom Fig. 1924 or equal.

2. 2-1/2" and Larger:
a. Pipe: Schedule 40, carbon steel, ASTM A53, Grade B electric resistance welded or seamless, ends beveled for welding.
b. Fittings: 150 pound class, Schedule 40, carbon steel, ends beveled for welding. All elbows long radium unless otherwise noted on the Drawings. ASTM A234, ANSI B16.9.
c. Flanges: 150 pound class, forged steel, welding neck type, raised face type, faced and drilled. ASTM A181, ANSI B16.5.
d. Flange Gaskets: 1/16" thick graphited asbestos.
e. Plug Valves: 150 pound series, flanged ends, cast-steel, lubricated, bolted gland type, wrench operated, ANSI B16.5. Norstrom Fig. 1925 or equal.

D. Appliance Pressure Regulator: Single stage, corrosion resistant natural gas pressure regulator capable of reducing the supply pressure to the operating pressure of the gas fired appliance. Regulator shall be comply with ANSI Z21.18 and may include vent limiting device instead of vent connection if approved by authorities having local jurisdiction. Acceptable Manufacturers are American Eaton, Harper Wyman and Maxitrol.

E. Service Pressure Regulator: Weatherproof, single stage, steel-jacketed, corrosion resistant natural gas pressure regulator capable of reducing the supply pressure to the operating pressure of the gas fired equipment. Include atmospheric vent, elevation compensator with threaded ends conforming to ANSI Z21.80 with 10 psig inlet pressure rating unless otherwise indicated. Acceptable Manufacturers are American Meter, Fisher Controls and Equimeter.

F. Miscellaneous: Provide all blinds, gaskets, bolts, etc. required for testing and cleaning procedures under this Section and conform to standards specified for adjacent materials.

PART 3 - EXECUTION

3.1 PREPARATORY WORK

A. Cleaning: Before erection, all piping shall be cleaned per NFPA No. 54 and as follows:
1. Loosen dirt, sand or scale by hammering or brushing.
2. Blow with air or hose with clean water.
3. Seal ends of pipe stored on the job site.

3.2 INSTALLATION

A. Install shutoff valve downstream from gas meter, outside of the building at the gas service entrance.

B. General:
1. All openings in the piping system shall be plugged to prevent the entry of foreign material when work is not being performed on the system.
2. Install drips at points where condensate may collect including outlets of gas meters. Locate where accessible to permit cleaning and emptying.
3. Install vent piping for gas regulators, gas trains and pipe sleeves, extend outside of building and vent to atmosphere. Terminate vents with turned-down, elbow fittings

with corrosion resistant insect screens.

C. Concealed Locations:
1. Install concealed gas piping in airtight pipe sleeve constructed of Schedule 40, seamless, back steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
2. No gas piping shall be allowed beneath foundations or building slabs.
3. Gas piping may be installed above accessible ceilings subject to approval of authorities having jurisdiction. Valves shall not be located in such spaces.

D. Install aboveground portions of natural gas piping systems that are upstream from equipment shutoff valves, electrically continuous, and bonded to grounding electrode according to NFPA 70. Do not use gas piping as grounding electrode.

E. Installation: Install per Section 23 05 00, NFPA No. 54, ANSI B31.3.0.

F. Welding: All welding shall be per Section 23 05 00 and be done by certified welders using one of the following methods:
1. Manual shield metal arc.
2. Tungsten inert gas (TIG).
3. Manual shielded metal art with TIG root pass.
4. Metal inert gas (MIG).

G. Threaded Connections:
1. Threads shall be cleaned out with no stripping or burrs.
2. Immediately before erection, remove all foreign matter from both male and female threads.
3. Coat the entire male thread surface with TFE thread tape.
4. Make up each joint sufficiently for the threads to seize.

H. Connections to Equipment:
1. All piping shall be arranged to facilitate maintenance and/or removal of equipment.
2. Provide flanges or unions at connections to equipment.
3. Install piping to equipment at full size indicated on the Drawings with any necessary reductions made at the equipment.

I. Valve Installation: Install valves with their stems aligned either horizontally or vertically upward unless specifically shown otherwise.

3.3 COMPLETED WORK

A. Clean-Up:
1. Prior to Flushing:
a. Remove all items which might by damaged by cleaning procedures and replace with spool pieces, plugs or blind flanges.
b. Install temporary strainers upstream from all items of equipment or disconnect the equipment from the system.
2. Flushing:
a. Fill headers with clean water after closing or disconnecting branch line.
b. Flush headers clean with a water velocity of approximately 8 fps.
c. When headers have been flushed clean, open or connect branch lines and flush them until clean.
d. Thoroughly dry with compressed air after flushing the system.
3. Resealing Systems:
a. Clean and reinstall all permanent strainers.
b. Reconnect all equipment and appurtenances except those items subject to

damage during pressure testing.

B. Testing:

1. General:

a. Remove all equipment and materials which could by damaged by the specified test from the system.

b. Test portions as required by construction schedule. When previously tested sections are expanded, retest at connections.

c. If pressure losses occur during tests, use suitable procedures to discover leaks, correct and retest. Repeat until system is tight.

d. Natural Gas and Propane Gas Lines shall be pneumatically tested at a minimum leak pressure of 1.5 times the normal operating pressure or 5 psig, whichever is greater, and the time interval shall be one hour.

END OF SECTION

SECTION 23 30 00

AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 DESCRIPTION

A. Provide complete air distribution system as specified herein and as indicated on the Contract Drawing including ductwork, dampers, access doors, grilles and registers, hangers and supports and other appurtenances.

1.3 QUALITY ASSURANCE

A. Observation: Inform the Owner's Representative of duct erection schedule so that he may observe ductwork during fabrication and all ductwork after it is installed. Ductwork shall not be concealed in any manner prior to inspection by the Owner's Representative except in cases where special permission is granted.

1.4 SUBMITTALS

A. Submit manufacturer's literature, engineering data and shop drawings in accordance with the requirements of Section 23 00 00 - General Mechanical Provisions.

B. Submit CAD generated scaled drawings of proposed ductwork. Drawings shall include the following:
1. Fabrication, assembly, and installation details, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Equipment installation based upon proposed equipment being used on Project.
9. Duct accessories, including grilles, registers and diffusers, balancing dampers, fire and smoke dampers, access doors and panels.
10. Hangars and supports, including methods for duct and building attachments, vibration isolation, and seismic restraints.

1.5 JOB CONDITIONS

A. Protection of Ceilings and Walls: The Contractor shall take all necessary precautions in order not to damage the ceiling tile or walls. Any such damage will be the responsibility of the Contractor to repair and/or replace.

PART 2 - PRODUCTS

2.1 GENERAL

A. All ductwork shown on the Drawings, specified or required for the heating, ventilating, and air conditioning systems shall be constructed and erected in a first-class workmanlike manner. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job against noise, chatter, whistling, or vibration, and free from pulsation

under all conditions of operation. After the system is in operation, should these defects occur, they shall either be removed and replaced or reinforced as directed by the Architect.

B. All ducts shall be erected in the general locations shown on the Drawings, but must conform to all structural and finish conditions of the building. Before fabricating any ductwork, the Contractor shall check the physical conditions of the job site, and shall make all necessary changes in cross sections, offsets, etc., whether they are specifically indicated or not.

C. Before starting shop drawings or fabrication of any ductwork, the Contractor must have an approved reflected ceiling plan with which he can coordinate location of air outlets, lights, tile patterns, etc.

D. The sizes of ducts indicated on the Drawings are the required net internal air stream dimensions, and where ducts are lined, the sheet metal sizes shall be increased by two inches (2") in both dimensions to accommodate the linings (1" thick lining, unless indicated otherwise).

2.2 MATERIALS

A. Sheet Metal:
1. Galvanized Sheet Steel: Lock forming quality (LFQ), with minimum galvanized coating of 1-1/4 oz. total for both sides of one square foot of a sheet. Provide mill-phosphatized finish for surfaces of ducts exposed to view.
2. Reinforcing: Reinforcing bars and angles shall be of the same material as ducts on which they are used.
3. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 DUCTWORK

A. Ductwork shall be classified, for construction standards, as follows:
1. All supply and return ductwork operating at pressures up to 2-1/2" W.G., is classified as low pressure ductwork and shall be constructed to those standards.
2. All exhaust ductwork shall be constructed in accordance with low pressure ductwork standards.

B. Except as noted otherwise, ducts shall be constructed of new galvanized prime grade steel sheets and the gauges of metal to be used, duct construction details, and the construction and bracing of joints shall be in accordance with the latest edition of the published standards of the ASHRAE Handbook or in accordance with the latest editions of Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) "Duct Manual" and "Balancing and Adjusting".

C. Rectangular low pressure ducts, systems operating at 2-1/2 inch W.G. or less, shall be constructed of the following medium gauges:

Largest Dimension of Duct	Gauge of Metal
Up to 12"	No. 26 U. S. Gauge
13" to 30"	No. 24 U. S. Gauge
31" to 54"	No. 22 U. S. Gauge
55" to 84"	No. 20 U. S. Gauge
85" and Above	No. 18 U. S. Gauge

D. Make square elbows where shown or required, with factory fabricated turning vanes. Job fabricated vanes will not be acceptable. Except as otherwise specified or indicated on the drawings, make all other changes in direction with rounded elbows having a centerline radius equal to 1-1/2 times the width of the duct in the plane of the bend.

E. Radius elbows shall have a centerline radius of 1-1/2 times the duct width.

F. Make transformations in duct shape or dimension with gradual slopes on all sides. Make increases in dimension in the direction of air flow, with a maximum slope of 1" in seven inches (7") on any side, but with a maximum slope of 1" in four inches (4") where conditions necessitate. Where transition must be made with less slope, install guide vanes to insure proper air flow.

G. Round low pressure ducts shall be spiral wound as manufactured by United Sheet Metal Company or shop fabricated round ducts with Pittsburg lock longitudinal seams. Gauges for shop fabricated ducts shall be as follows:

Up to 12" in Diameter	No. 26 Gauge
13" to 30"	No. 24 Gauge
31" to 42"	No. 22 Gauge
43" to 60"	No. 20 Gauge

Elbows shall have a centerline radius of 1-1/2 times duct diameter and may be smooth elbows or 5 piece 90 degree elbows and 3 piece 45 degree elbows. Joints of round ducts shall be slip type with a minimum of three sheet metal screws.

H. All low pressure ductwork shall be externally sealed using United Sheetmetal, MMM EC-800, or Hardcast duct sealer installed in the joints prior to closure.

I. With the exception of continuously welded joints and machine-made locking-type longitudinal joints and seams, all longitudinal and transverse joints, seams and connections shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems or tapes installed in accordance with manufacturer's installation instructions.

2.4 HANGERS AND SUPPORTING SYSTEMS:

A. Hanger and supporting systems shall be as shown on Drawings. Where not shown on Drawings, make hangers and supporting systems in accordance with SMACNA standards with the following exceptions:

1. Support overhead galvanized ducts by galvanized steel straps, or by galvanized angle iron trapeze hangers. Hangers shall be securely bolted with at least two bolts to a side to pocket slips, or, where installed between joints, they shall be bolted to sides and bottom of ducts. Strap hangers shall extend to bottom of ducts and shall be folded 180 degrees to the opposite side of flanges or 90 degrees to bottom of duct as required. Install hangers at least every 8'-0". Wire and perforated strap hangers shall not be permitted.
2. Strap hangers shall be no smaller than 1" x 1/16" for ducts 18" and less on maximum side, 1" x 1/8" for ducts 19" to 60" on maximum side, and 1-3/8" x 1/8" for larger ducts.
3. Attach hangers to building structure by use of approved steel hanger clamps or by welded studs. All miscellaneous steel required for supporting ducts shall be furnished by the air conditioning contractor.
4. Install sway bracing wherever required to assure proper rigidity of ductwork installation.

2.5 FLEXIBLE DUCTWORK

A. Flexible ductwork shall be a factory fabricated assembly consisting of an outer vapor barrier jacket of non-toxic polyethylene, a uniform layer of fiberglass insulation and a high-strength steel helix encapsulated in a polyethylene film interior core. A 1" thick insulating blanket of

fiberglass, providing a thermal conductance ("C" Factor) of 0.28 BTU/sq. ft./°F, shall encase the polyethylene outer jacket helix. The flexible duct shall be rated for a maximum working velocity of 4000 FPM, four inches (4") positive pressure, five inches (5") negative pressure and shall be listed by Underwriters Laboratories Inc. under their UL-181 standards as a Class I Air Duct and shall comply with NFPA Standard 90A. The flexible duct shall be as manufactured by Wiremold, Flexible Tubing, Thermoflex, or Genflex.

B. Take-off from branch or plenum ducts to air terminal devices shall be die stamped of heavy gauge steel so as to provide a uniform and rigid connection. The connector shall be Genflex SM-2DG series spin-in with integral damper or approved equal.

C. Secure duct by sliding onto connector and securing with plenum rolled nylon or teflon strap clamp. Fold insulated vapor barrier jacket over clamp and make vaportight with Arno duct tape (2") 2 times around the duct.

D. Unless otherwise noted, the maximum length of flexible duct shall be limited to six feet (6').

E. Duct and insulation shall be tested in accordance with ASTM E84, shall conform to NFPA and meet or exceed the following:
   1. Flame Spread Rating: 25 or less
   2. Smoke Developed Rating: 50 or less

2.6 GRILLES, REGISTERS, AND DIFFUSERS

A. Grilles, registers, and ceiling outlets shall be as scheduled on the Drawings and shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, drop, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturers' own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 FPM or less than 25 FPM. Noise levels shall not exceed those published in the ASHRAE guide for the type of space being served (NC level).

B. Locations of outlets on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures or Architectural reflected ceiling plan. Where called for on the schedule, the grilles, registers, and ceiling outlets shall be provided with deflecting devices and manual dampers. These shall be the standard product of the manufacturer, subject to review by the Architect.

C. Grilles, registers, and diffusers shall be as manufactured by Titus, Price, or Krueger.

2.7 AIR CONTROL DEVICES

A. Splitter Dampers:
   1. Material of splitter dampers shall be same as ducts in which they are installed. Gauge metal shall be same as duct gauge, but not lighter than 20 gauge steel.
   2. Fabricate damper blade of two thicknesses of metal formed to provide a round leading edge with radius of leading edge 1/4 inch or larger. Press metal sides together at leading edge, and bend one side 180° around the other to make a two-inch wide hemmed edge. Make blade 1-1/2 times the width of smallest duct it serves, but not less than 12 inches long.
   3. Provide height of blade as near the height of duct as possible with enough clearance to prevent scraping or binding.
   4. Securely hinge leading edge to duct with two Ventlock No. 370 hinges or approved equal for dampers 16" or less in height. Use an additional hinge for each 16", or fraction thereof, additional height.
   5. Operating rods shall be 5/16" steel rods hinged to leading edge of damper and

extending through side of duct and through Ventlock No. 603 ball joint brackets, or approved equal. Firmly bolt brackets to outside of duct. Reinforce side of ducts where operating rods pass through by riveting or bolting a 2" by 1/4" strap to the duct. Bolt ball joint brackets to duct and strap. Bend operating rods 90°, four inches from out ends, and make long enough to permit full operation of damper. Use one operating rod for each 16" of damper blade height or fraction thereof. Evenly space rods.

B. Single Blade Dampers: Fabricate single blade dampers in accordance with SMACNA standards with the following exceptions:
   1. Interior steps or seals are not required. These dampers are used for balancing, and tight shutoff is not required.
   2. For ducts with exterior insulation, use a "hat channel" between the duct and locking quadrant to bring the quadrant to the outer surface of the insulation, or use a 644 Ventlock Self-Locking Regulator or approved equal.

C. Multiblade Dampers:
   1. Use manually controlled multiblade dampers for system balancing in ducts which are more than 13 inches high.
   2. Multiblade dampers shall be opposed action dampers, constructed in accordance with SMACNA standards and shall be American Foundry and Furnace Company Model ACD-2/P, or approved equal, with shaft extension, manual lever and quadrant.
   3. Where multiblade dampers are installed in ducts which have external insulation, use a "hat channel" between duct and locking quadrant to bring quadrant to outer surface of insulation or use of 644 Ventlock Self-Locking Regulator or approved equal.
   4. Blade shafts and bearings shall be of materials that will not rust or bind.

D. Backdraft dampers shall be self-operating, and counter-balanced to close by gravity. Dampers shall be aluminum, with 16 gauge frames, 0.023 inch blades of flat or elliptical shape, and with tie bars to connect blades for parallel operation. Each damper blade shall have gaskets for air seals and for quiet operation. Blade pivots shall have nylon bushings. Provide adjustable counter-balance weights where required. Provide motorized dampers where specified.

E. Barometric relief dampers shall be low leakage type multiblade dampers and shall start to open at a preset pressure. Available pressure range shall be 0.125 through 1.0 inch w.g. Leakage through damper shall not exceed 36 cfm per square foot at 1 inch w.g. differential pressure when tested in accordance with AMCA Standard 500. Frames shall be constructed of 3-1/2 x 1 inch x 16 gauge galvanized steel hat channels. Blades shall be 16 gauge galvanized steel equipped with vinyl seals. Jambs shall have EPT sponge seals. Axles shall be 1/2 inch diameter galvanized steel. Bearings shall be press-fit ball.

2.8 FIRE AND SMOKE DAMPERS

A. Fire dampers shall be installed in air passages, openings, ductwork wherever shown on the drawings, and/or required by the local authorities having jurisdiction.

B. Fire dampers shall be constructed in accordance with the recommendations of NFPA and shall be of metal gauges required by the class of separation each case. They shall carry the U.L. Label and shall be installed such as to conform to conditions under which U.L. Label was granted.

C. Fire Dampers:
   1. Fire dampers shall be of solid steel curtain type with corrosion resistant steel blades and with frames which shall be continuous one-piece roll formed construction with mounting flanges. In closed position the blades shall interlock completely. Horizontally mounted dampers shall close and shall be locked by the use of stainless steel springs with constant tension design such that the combined tension of the

springs is equal to at least 2.5 times the force required to close the damper curtain. Damper reset shall be accompanied by use of access panels.

2. Fire dampers for low pressure rectangular duct shall have frames with 95% or greater free area.
3. Fire dampers for medium pressure rectangular duct shall have frames with 100% free area.
4. Fire dampers for round duct shall have frames with 100% free area.

D. Combination Smoke/Fire Dampers:

1. Combination smoke/fire dampers shall be of multiblade type with very low leakage, non-heat degradable design with friction free metal to metal seals incorporated into the blade and frame shapes. Other types of gasketing to achieve very low leakage performance such as petrochemical (vinyl, plastic, etc.), spring stainless steel, aluminum, etc. will not be accepted.
2. All combination smoke/fire dampers shall incorporate one compact UL classified safety made operator which performs the following functions:
   a. Extended shaft damper drive transmission with linear control.
   b. Smoke detector signaled release.
   c. Reusable high ambient temperature release.
   d. Spring closed, mechanical lock closed that is independent of motor actuator position or condition.
   e. Automatic reset upon cessation of detector signal, 120V or 24V A.C. or D.C.
   f. Automatic reset upon normalization of duct air temperature.
3. Electric motor actuators shall be UL listed and furnished with all necessary mounting and location hardware for installation outside of the ductwork.
4. Combination smoke/fire dampers shall be furnished with connecting shafts and linkages utilizing not more than one actuator for single and multiple assembly sizes up to 16 square foot.

2.9 ACCESS DOORS

A. Provide in the ductwork, hinged access doors to provide access to all fire dampers, automatic dampers, etc. Where the ducts are insulated the access doors shall be double skin doors with 1 inch of insulation in door. The access section shall be fabricated of 20 gauge galvanized steel. The housing shall be of welded construction with a pressure seal gasket around the cover.

2.10 FLEXIBLE CONNECTIONS

A. Where ducts connect to fans, including roof exhausters, flexible connectors shall be made using glass fabric double coated with polychloroprene that is fire-resistant, waterproof, mildew-resistant and practically airtight, and shall weigh approximately thirty ounces (30 oz.) per square yard.

B. There shall be a minimum of one-half inch (1/2") slack in the connections, and a minimum of two and one half inches (2-1/2") distance between the edges of the ducts except that there shall also be a minimum of one inch (1") of slack for each inch of static pressure on the fan system.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Furnish and install all ductwork, grilles, registers, diffusers, dampers, and all auxiliary work of any kind necessary to make the various air conditioning, ventilating, and heating systems of the building complete and ready for operation.

B. The entire installation shall be in accordance with local codes, SMACNA, ASHRAE, NFPA,

and manufacturer's recommendations.

3.2 DUCTWORK INSTALLATION

A. All ductwork shown on the Drawings, specified or required for the heating, ventilating, and air conditioning systems shall be constructed and erected in a first-class, workman-like manner.

B. The duct system shall be fabricated and installed as shown on the Drawings to give a complete workable duct system and shall be equal to the recommendations of current SMACNA Standards. Ducts shall be straight and smooth on the inside with neatly finished joints, airtight, and shall be free from vibration under all conditions of operation. The ducts shall be securely attached to the building construction in an approved manner.

C. Where ducts are stacked they shall be independently supported.

D. All ductwork passing through a wall, floor, ceiling or similar structure that is exposed to view shall have a sheetmetal collar that extends a minimum of 2 inches out from each side of the duct to provide a neat installation appearance.

E. Flexible ducts shall be installed in accordance with manufacturer's recommendations. All joints and connections shall be made with positive locking steel straps and approved mastic, and shall be taped. Flexible ducts shall be installed fully extended, free of sags and kinks, and bends shall have a minimum radius of 1.5 duct diameters measured from the centerline. Where horizontal support is required, ducts shall be suspended on 36 inch centers with a minimum 3/4 inch wide flat bonding material. Flexible ducts shall not exceed 6 feet in length.

3.3 GRILLES, REGISTERS, AND DIFFUSERS

A. Install grilles, registers, and diffusers at locations shown on the drawings using the scheduled size and type.

B. Adjust grilles to be square to ceiling pattern and for proper fit to ceiling.

C. Adjust pattern control blades for proper throw.

D. Install all miscellaneous transfer and return air grilles and registers in ceilings and walls for return of air to the respective air handling units or for relief to atmosphere.

3.4 AIR CONTROL DEVICES

A. Provide manually operated volume control dampers in duct branches, splits, and taps for proper balancing of air distribution.

B. Butterfly dampers shall be provided at each tap to a supply air grille or diffuser.

C. Splitter dampers shall be provided at each branch take-off, elsewhere as required for proper balancing of systems, and elsewhere as called for on Drawings.

D. All dampers in furred spaces having accessible and/or removable ceilings shall have Young, Elgen, or Ventfabric damper locking quadrants with end bearings. All dampers in inaccessible furred spaces or drywall ceilings shall have the operating rod through furring or down to ceiling and terminated with a damper regulator and plate, prime coat finish.

3.5 FIRE AND SMOKE DAMPERS

A. Provide fire dampers in supply, recirculation, and exhaust ducts wherever indicated on Drawings, wherever such ducts pass through fire walls or partitions, as required by the National Board of Fire Underwriters Pamphlet 90A recommendations, applicable local codes,

and other governing authorities.

B. Provide smoke dampers or combination fire/smoke dampers wherever indicated on Drawings or as required by local codes and other governing authorities.

C. Fire and smoke dampers shall be installed so as to provide a positive barrier to passage of air when in a closed position. Dampers shall be installed so they will be self-supporting in case of duct destruction due to heat. Care must be exercised that the frame be set so that the closing device will not bind.

3.6 ACCESS DOORS

A. Provide hinged access doors where required in ductwork for access to all variable air volume box mechanisms, humidifiers, smoke detectors, sensors, and other control devices, manual dampers, automatic dampers, fusible links, and for cleaning operations.

B. Locate access doors so they are easily accessible.

3.7 CLEANING

A. Before grilles and diffusers are installed operate the fans and thoroughly blow out the interior surfaces of all ductwork, remove debris from inside of ducts and cause the duct system to be completely free of dirt and debris and foreign materials.

3.8 TESTING

A. Ducts shall be checked for leaks which can be detected by careful listening or feeling along the joints and seams. Leaks detected by this procedure shall be repaired.

B. Adjust all duct accessories for proper settings.

END OF SECTION

SECTION 23 34 16

CENTRIFUGAL FANS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. The scope shall include all centrifugal fans, supports and all appurtenances.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the manufacturer.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions. Submit fan curves for all fans.

B. Shop Drawings: Submit in accordance with Section 23 00 00 - General Mechanical Provision.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 00 00 - General Mechanical Provision.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. General: Fans shall be furnished complete with motor and pre-wire safety/disconnect switch. Motors shall be totally enclosed, fan cooled, and shall be sized to prevent overloading. Single phase motors shall have built-in thermal overload protection. Safety/disconnect switches shall be as specified in Division 26.

B. Roof or Wall Centrifugal Exhausters:
   1. Exhausters shall be direct driven or V-belt driven, as indicated in the schedule. Direct drive fans shall be selected on basis of maximum efficiency. Belt drive fans shall be selected to have maximum speed of not less than 20% above design speed. Drives shall be designed for not less than 150% of connected motor horsepower. Motor sheaves shall be adjustable to provide not less than 20% speed variation and shall be selected to produce specified capacity when set at midpoint of sheave adjustment. Belt drive fans shall be furnished with an adjustable motor base.
   2. Rotating unit of each fan shall be statically and dynamically balanced at factory for vibration free performance through maximum catalog rated speed. Fan shall

not exceed 80% of first critical speed when operating at maximum speed.

3. Fan Wheel shall be fabricated from dieformed or molded metal with single thickness backwardly including blades.
4. Fan Housing shall be rigidly braced and fabricated of aluminum. Housing shall be weather proof and complete with back-draft dampers and bird screen. Roof-mounted fans shall be furnished with a factory fabricated curb (12 in. minimum height) and curb flashing (2 in. minimum depth). Wall mounted fans shall be designed to discharge air away from building wall.
5. Fan bearings shall be self-aligning, anti-friction ball or roller and shall have a minimum L-10 bearing life based on 120,000 hours. Bearings shall be pillow block mounted, lubricant retaining, and shall have dust excluding seals at each end.

C. In-Line Centrifugal Fans

1. Fans shall be centrifugal, duct mounted type. The fan housing shall be of the square design, constructed of galvanized steel and shall have square duct mounting collars.
2. Fans shall be direct driven or V-belt driven, as indicated on the Drawings. Direct drive fans shall be selected on basis of maximum efficiency. Belt drive fans shall be selected to have maximum speed of not less than 20% above design speed. Drives shall be designed for not less than 150% of connected motor horsepower. Motor sheaves shall be selected to produce specified capacity when set at midpoint of sheave adjustment. Belt drive fans shall be furnished with an adjustable motor base.
3. Rotating unit of each fan shall be statically and dynamically balanced at factory for vibration free performance through maximum catalog rated speed. Fan shall not exceed 80% of first critical speed when operating at maximum speed.
4. Fan Wheel shall be fabricated from dieformed or molded metal. Blades shall be aluminum backwardly inclined, backwardly curved, or backwardly inclined air foil, non-over loading type. Inlet orifices shall be deep, spun venturi type for high efficiency and non-turbulent air entrance condition.
5. Fan Housing shall be rigidly braced and fabricated of heavy gauge steel. One side of housing shall have a gasketed hinged access door. The housing shall be equipped with a minimum of four hanger brackets with neoprene vibration isolators.
6. Fan bearings shall be self-aligning, anti-friction ball or roller and shall have a minimum L-10 bearing life based on 200,000 hours. Bearings shall be pillow block mounted, lubricant retaining, and shall have dust excluding seals at each end.
7. Fan Motors shall be permanently lubricated, continuous duty type. Motors shall be factory wired with flexible conduit to an external mounted combination junction box and safety switch. All wiring shall comply with National Electric Code and UL approval.
8. Fans shall bear the AMCA Certified Rating Performance Seal for both air and sound performance.

D. Acceptable Manufacturers

1. ACME
2. Greenheck
3. Cook

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all centrifugal fans per manufacturer's recommendations, contract documents and approved shop drawings.

B. Secure roof-mounted fans to curbs with cadmium-plated hardware.

C. Install fans with clearances for service and maintenance.

END OF SECTION

SECTION 23 81 21

PACKAGED ROOF TOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 0 and Division 1 for related contractual requirements.

B. Comply with Division 23 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION

A. The scope shall include all packaged roof top air conditioning units, supports and all appurtenances.

1.3 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality.

B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the manufacturer.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature and installation instructions. Submit fan curves for all fans.

B. Shop Drawings: Submit in accordance with Section 23 00 00 - General Mechanical Provisions.

1.5 PRODUCT HANDLING

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall and will be rejected.

B. Storage and protection of materials shall be in accordance with Section 23 00 00 - General Mechanical Provisions.

PART 2 - PRODUCTS

2.1 PACKAGED ROOF TOP AIR CONDITIONING UNITS WITH GAS HEAT

A. General: Packaged roof top air conditioning unit shall be factory assembled, single-piece heating and cooling unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410a), and special features required prior to field start-up.

B. Unit Cabinet: Unit cabinet shall be constructed of heavy gauge galvanized steel, bonderized or phosphatized and finished with a pre-painted baked enamel finish on all externally exposed surfaces. Evaporator fan compartment interior cabinet surfaces shall be insulated with a flexible fiberglass insulation, coated on the air side. Aluminum foil-faced fiberglass insulation shall be used in the gas heat compartment. Cabinet panels shall be easily removable for servicing. Unit shall have a factory-installed condensate drain pan made of a non-corrosive material, providing a minimum 3/4-in. connection. Unit shall have a factory-installed filter access door to provide filter access with no panel or screw removal.

C. Fans:

1. Evaporator fan shall be direct or belt driven as shown on the equipment drawings.

Belt drive shall include an adjustable-pitch motor pulley. Fan wheel shall be double-inlet type with forward-curved blades. Bearings shall be sealed, permanently lubricated ball-bearing type for longer life and lower maintenance. Evaporator fan shall be made from steel with a corrosion-resistant finish and shall be dynamically balanced.

2. Condenser fan shall be of the direct-driven propeller type and shall discharge air vertically. Condenser fan shall have aluminum blades riveted to corrosion-resistant steel spiders and shall be dynamically balanced.
3. Induced-draft blower shall be of the direct-driven, single inlet, forward-curved centrifugal type, made from steel with a corrosion-resistant finish and shall be dynamically balanced.

D. Compressor(s): Compressors shall be hermetic type, internally protected and shall be internally spring mounted for vibration isolation.

E. Coils: Evaporator and condenser coils shall have aluminum plate fins mechanically bonded to copper tubes with all joints brazed. Evaporator coil shall be of the full face active design.

F. Heating Section: The heat exchanger shall be of the manufacturer's standard construction for gas fired heat exchangers and burners with the following controls:
1. Redundant gas valves.
2. Intermittent pilot ignition with electronic spark ignition or pilotless hot surface ignition.
3. High limit cut-out.
4. Forced draft proving switch.

G. Refrigerant Components: Refrigerant circuit components shall include refrigerant strainer and service gage connections on suction, discharge and liquid lines.

H. Motors:
1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have line break thermal and current overload protection.
2. Evaporator-fan motor shall have permanently lubricated bearings and inherent automatic-reset thermal overload protection.
3. Totally enclosed condenser-fan motor shall have permanently lubricated bearings, and inherent automatic-reset thermal overload protection.
4. Induced-draft motor shall have permanently lubricated sealed bearings and inherent automatic-reset thermal overload protection.

I. Filter Section: Filter section shall consist of factory-installed, low velocity, throwaway 2-in. thick fiberglass filters of commercially available sizes. Filter face velocity shall not exceed 320 fpm at nominal airflows. Filter section should use only one size filter.

J. Controls and Safeties: Unit shall be complete with self-contained low-voltage control circuit protected by an auto-reset device. Unit shall incorporate compressor over-temperature and over-current safety devices to shut off compressor and cycle delay to prevent compressor from restarting for a minimum of 5 minutes after shutdown. Heating section shall be provided with high-temperature limit switch, induced-draft motor speed sensor, flame rollout switch, and flame proving controls.

K. Operating Characteristics: Unit shall be capable of starting and running at 115 F ambient outdoor temperature, meeting maximum load criteria of ARI Standard 210/240 or 360. Compressor with standard controls shall be capable of operation down to 25 F ambient outdoor temperature.

L. Economizer: Where indicated on the drawings, economizer shall consist of a fully modulating 0-100% motor and dampers assembly, barometric relief, minimum position setting, preset linkage and solid state enthalpy or differential enthalpy controls.

M. Motorized Outside Air Damper: Where indicated on the drawings, motorized outdoor air dampers shall provide up to 50% outside air. Once set, outdoor air dampers shall open to set position when indoor fan starts. The damper shall close when the indoor fan shuts down.

N. Electrical Requirements: All unit power wiring shall enter unit cabinet at a single factory-predrilled location.

O. Thermostat: Provide 7-day programmable thermostat with automatic changeover.

P. Smoke Detectors: Where indicated on the drawings, provide photoelectric smoke detector located in the supply/return air duct/plenum as required by authorities having jurisdiction. Smoke detector shall automatically de-energize the unit upon activation.

Q. Roof Curb: Roof curb shall be manufacturer's standard, insulated with corrosion protection coating, gasketing, factory installed formed galvanized steel with wood nailer strip capable of supporting entire unit weight. Where indicated on the drawings, provide isolation curb constructed with rigid upper and lower steel structure with vibration isolation springs and vertical and horizontal restraints and elastomeric waterproof membrane. Springs shall be selected for 2" static deflection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine roof for compliance with requirements for conditions affecting installation and performance of rooftop units. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Install packaged roof top air conditioning as recommended by the unit manufacturer and as shown on the drawings. Units shall be installed level and plumb and manufacturer's recommended clearances shall be maintained.

C. Curb Support: Where specified and shown on the drawings, install roof curb on roof structure, level, according to NRCA's written installation instructions. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.

D. Unit Support: Where specified and shown on the drawings, install unit on structural curbs and level. Coordinate wall and/or roof penetrations and flashing with wall/roof construction.

E. Adjust fan drives as directed to obtain scheduled capacities.

3.2 COMMISSIONING

A. Verify that installation is as indicated and specified.

B. Clean coils and condensate pans after installation of air conditioning units is complete.

C. Clean all debris from inside air conditioning unit casings.

D. Complete manufacturer's installation and startup checks and perform the following:
1. Level unit on housekeeping base and flash to unit and to roof.
2. Inspect for visible damage to unit casing, furnace combustion chamber, compressor, condenser coils, and fans..
3. Check that labels are clearly visible.
4. Verify that controls are connected and operating properly.
5. Remove shipping bolts, blocks and tie-down straps.
6. Verify that filters have been installed.
7. Adjust vibration isolators.

8. Connect and purge gas lines.
9. Check operation of barometric dampers.
10. Lubricate bearings on fans.
11. Check fan wheel rotation for correct direction without vibration or binding.
12. Adjust fan belts to proper alignment and tension.
13. Calibrate thermostats.

E. Start unit in accordance with manufacturer's written recommendations.

F. Check and record performance of interlocks and protection devices including outside air dampers; verify sequences.

G. Operate unit for an initial period as recommended by the manufacturer.

H. After starting and performance testing, change filters, vacuum heat exchanger and cooling and condenser coils, lubricate bearings, adjust belt tension, and check operation of power vents.

END OF SECTION

SECTION 26 00 00

GENERAL ELECTRICAL PROVISIONS

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish all labor, materials, equipment, tools and services in connection with, or properly incidental to the furnishing of equipment, installing equipment and the construction of electrical systems as described in this Division of the Specifications and/or shown on the accompanying Drawings, or reasonably implied therefrom, except as hereinafter specifically excluded.

B. Furnish all additional details or special construction as required for work indicated or specified in the division or work specified in other divisions. Furnish and install all material and equipment usually furnished with systems or required to complete and make operative the installation, whether specifically mentioned or not.

1.2 REFERENCE DOCUMENTS:

A. The Electrical Drawings are a combination of scale and symbolic representation of the electrical systems required to be installed. The drawings and specifications are based on qualified skilled craftsmen procuring and installing the work. The drawings include symbolic indication of branch circuit conductors, connections to devices, hook-up of electric powered equipment, etc.

B. Division 26 00 00 Work includes proper routing of raceways, grouping of conductors, wiring to and hook-up of devices and equipment in accord with the total provisions of the specifications. Refer to the symbol schedule for the basis of the drawing representation. Symbols other than those in the schedule are explained elsewhere or are those commonly used in the industry. Listing of a symbol in the schedule does not imply that the symbol is used on the final contract documents. The electrical drawings indicate general locations of devices and equipment, but final locations shall be determined in reference to the Architectural, Structural, Mechanical and Electrical Drawings.

C. The Architectural, Structural and Mechanical Drawings and Specifications including all Supplements issued thereto, are a part of these Specifications and the accompanying Electrical Drawings, and shall be complied with in every respect.

1.3 REGULATIONS, PERMITS AND APPROVALS:

A. The installation including all materials and equipment shall conform to NFPA No. 70; the applicable requirements of the utility companies supplying energy, communications and other services to the project; the laws of the City pertaining to electrical installation; and with all national, state and local codes and laws relating to construction, building and public safety.

B. Each of the above regulations are minimum standards. Where the requirements of these minimum standards are less than or do not conflict with the requirements of the Contract Documents, the Contract Documents shall be followed.

C. Obtain all permits and arrange for all inspections and approvals for the work including construction document review and site observations by the authorities having jurisdiction. Obtain certificates of inspection and acceptance and transmit these to the Architect as a condition of acceptance. Assume and pay all fees and other costs involved in obtaining the permits, inspection certificates and approvals as a part of Division 26 00 00 Work.

1.4 SHOP DRAWINGS AND OTHER SUBMITTAL:

A. Submit Shop Drawings or fully descriptive catalog data for all items of materials and equipment proposed to be furnished and/or installed. Submit sufficient copies to provide reviewed copies as need to be returned plus three (3) copies for retention by the Architect.

B. Submit on all Electrical Distribution Equipment, wiring materials, lighting fixtures and all components of communication, signal, protection and alarm systems. The submittal of free standing electrical equipment shall include scale drawings indicating the proposed layout of this equipment within the space allocated and the proximity of existing work, other electrical work, and work installed under other divisions of work.

C. Submit sufficiently early to allow ample time for checking without delaying delivery of the materials to job site. A review of any submittal which results in a requirement to resubmit shall not be justified basis of work delay or extra cost.

D. The review of Shop Drawings or catalog data by the Architect shall not negate the Contractor's responsibility for deviations from the Drawings and Specifications unless, in writing, attention is specifically noted for such deviations at the time of submission and acceptance of the Architect is noted thereon. When attention is called to deviations from the Drawings and Specifications, state in letter of transmittal whether or not such deviations involve any change in contract time and cost. Errors of any kind associated with submittal shall be the responsibility of the installer of Division 26 00 00 Work.

1.5 STANDARDS FOR ELECTRICAL MATERIALS:

A. Materials shall be new and free from defects and shall conform with the standards of the Underwriters' Laboratories, Inc., in every case where such standards have been established. Evidence of such conformance shall be the UL label or "listing" by Underwriters' Laboratories, Inc. under Re-examination Service.

B. The Specifications indicate a standard of quality for materials. Manufacturer's names and catalog numbers are used to designate materials or equipment to establish grade and quality. Where several manufacturers are named, the bid shall be based on those named manufacturer's products. Where only one manufacturer is named, unless stated otherwise, manufacturers of equal quality products will, however, be considered as substitutions only after the award of the Contract.

1.6 SUBSTITUTIONS:

A. In the event substitutions are to be submitted for Owner review, furnish descriptive catalog material, test data, samples, etc., of both the specified material and the proposed substitute, as well as any other pertinent data necessary to demonstrate that the proposed substitutions are acceptable equals to the specified products.

B. Substitutions shall not be made without written acceptance and the lack of acceptance shall not be basis of change in the work.

PART 2. PRODUCTS

2.1 PAINTS AND PROTECTIVE COATINGS:

A. For exposed hangers and supports: not provided with factory protected finish: Sherwin-Williams Kromik primer and Metalatex semi-gloss enamel.

B. Materials and Equipment: Sherwin-Williams Kromik primer and Metalatex semi-gloss enamel.

2.2 NAMEPLATES:

A. Nameplates shall be laminate plastic name plates with one-fourth inch (1/4") high letters engraved thereon which give contract identification, electric service characteristics and source of power on each of the items of equipment. Nameplates for items of equipment, on Life Safety System including transfer switches shall be red with white letters and all others shall be black with white letters unless specifically noted otherwise.

B. Name plates shall be fastened on with cadmium or plated screws.

PART 3. EXECUTION

3.1 EXAMINATION OF SITE:

A. Visit the site of the proposed work and carefully examine the existing conditions and limitations thereof, and include in the bid all costs of any kind whatsoever which are incurred through limitations of the existing conditions.

3.2 SERVICE, CONNECTIONS AND PERMITS:

A. Obtain all permits, inspections and approvals for the work including construction document review and site observations by the authorities having jurisdiction. Obtain certificates of inspection and acceptance and transmit these to the Architect as a condition of acceptance. All fees and other costs involved in obtaining these permits, inspections and approvals shall be assumed and paid under this Division of the Work.

B. Arrange for all services and pay all costs whatsoever to completely install and place in operation these electrical systems.

3.3 COORDINATION:

A. Coordinate work with that of other trades and adjacent projects to make proper connections at appropriate locations and times. Review the construction of other trades and adjacent projects to determine the physical needs and time requirements imposed in providing connections to them as shown on the drawings and in accordance with the project schedule.

B. Coordinate work with that of the other trades so work may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Give precedence to lines which require a stated grade for proper operation. Where space requirements conflict, the electric conduit shall, in general, yield to all other trades.

C. When any electrical equipment is operable and it is to the advantage of the project, the equipment may be operated providing that prior approval of the Owner is received and proper supervision of the equipment operation performed. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner. Regardless of whether the equipment has or has not been operated, properly maintain the equipment; and at the completion of the work, properly clean, adjust, and complete all items before final acceptance is requested.

D. The Architect or others may, during the execution of the work, desire to make corrections to or modifications of work installed in this Division of Work. Permission for the Architect or others to make these connections or modifications shall be granted without relieving responsibility for work installed under this Division of Work.

3.4 RECORD DRAWINGS AND BROCHURES:

A. During the execution of work, maintain a complete set of reproducible drawings upon which all dimensional locations of equipment, deviations and changes in the work shall be recorded.

These Record Drawings shall be in good condition and shall be marked "Record Drawings", signed, dated and transmitted with two sets of prints under a transmittal letter to the Architect upon completion and acceptance of the work and before final payment is made.

B. The following data as applicable to the work shall be included in items furnished for use by the Owner:
   1. Record Drawings as specified above and elsewhere.
   2. Six (6) brochures of lighting fixtures with copies of data of each installed luminaire. Index each brochure indicating fixture type, manufacturer and catalog number, voltage, and lamping.
   3. Six (6) brochures of Electrical Distribution Equipment with final drawings, operating instructions and maintenance instructions.

3.5 CARE AND CLEAN UP OF EQUIPMENT AND MATERIALS:

A. Protect each item and component of electrical equipment from moisture, concrete, mortar, paint, dust and other foreign materials from the time it arrives on the job site until installed, placed in service and accepted by Owner, using signs, barriers and other means where by others are made fully aware of the importance of protecting equipment from damage.

B. Keep all electrical construction materials clean of all foreign materials from the time of arrival on the site until their installation. Time the installation of each item to avoid unnecessary exposure of the materials to destructive elements or destructive environment. Clean all installed materials of all foreign materials including concrete, mortar, spilled paint, and dust prior to final inspection. All unused electrical construction materials shall be removed from the site.

C. After the installation is complete and before equipment is energized, thoroughly clean the interior and exterior of all equipment and materials. After the building is completed and cleaned, arrange for a power outage on each item of equipment and repeat the cleaning. This cleaning shall be performed just before final inspection. Each component shall be cleaned with air pressure, vacuumed and wiped clean of all dust and other foreign material. Components shall be cleaned of all oxidation. Any portion needing touch-up finishing and/or protective coating shall be so finished to equal the specified finish on the product.

D. Provide for the removal of all unused, scrap, material containers and other rubbish or trash resulting from Division 26 00 00 Work from within and around all work and work areas on a basis that it will not interfere with other trades, other work or the completion of any work.

3.6 PAINTING AND PROTECTION:

A. Electrical equipment such as primary switches, switchboards, panelboard fronts, motor control centers and transformers shall be delivered to the job with suitable factory finish. Finishes marred in transit or during installation shall be refinished under this Division of Work to present a neat, workmanlike appearance equal to the factory finish.

B. Except as elsewhere required, painting of equipment,boxes, conduit, etc., furnished under this Contract will be performed under another division of work. Clean electrical work of all trash, dirt, marks, and other foreign materials under this Division of Work prior to the application of finishes.

C. Electric work in areas of the construction to remain unpainted shall be protective finished under this Division of Work as follows unless indicated otherwise:
   1. Paint all exposed and non-rust inhibited hangers and supports not provided with a factory finish with primer and two (2) coats of enamel.
   2. Material and equipment with suitable factory-applied finishes may be left unpainted provided the Architects' approval to do so is obtained. Prime and paint material and

equipment that does not obtain such approval with two (2) coats of semi-gloss enamel.

D. Painting in finished areas of the construction where finished coatings are applied under other divisions of work shall be performed under other Division of Work and shall include:
   1. All exposed hangers and supports and all exposed conduits and boxes with a coat of primer, and two (2) coats of semi-gloss enamel and all panel boards and other cabinets with two (2) coats of semi-gloss enamel.
   2. Concrete foundations with one (1) coat of masonry paint and one (1) coat of enamel.
   3. Equipment with suitable factory-applied finishes left unpainted provided Architect approval is obtained prior to beginning of painting in the area. Material and equipment that does not obtain such approval shall be primed and painted two (2) coats of enamel.

E. Painting done shall be in colors designated by the Architect. Successive coats of paint shall be of different shades.

3.7 CUTTING AND PATCHING:

A. Do all cutting necessary for the installation of Division 26 00 00 Work. Cutting shall be carefully and neatly done so as not to damage or cut away more than necessary.

B. Where Division 26 00 00 workmen damage or cut away work excessively, patching will be performed as a part of Division 26 00 00 Work. Patching will be by craftsman experienced in performing this type of work.

3.8 NAMEPLATES:

A. Install nameplates which give contract drawing identification and electric service characteristics on equipment unless specifically indicated otherwise including switch gear, switch boards, transformers, panel boards, and main control cabinets for alarm systems. Typed directories shall be provided for branch panel boards.

B. In each case where compartments, equipment, etc., are required to be "labeled" or "identified", it shall be construed that nameplates are to be installed.

C. Locate nameplates on the exterior face of the equipment so as to be clearly visible when the equipment is in place.

D. Fasten nameplates on with screws except contact-type permanent adhesive shall be used where screws cannot or should not penetrate enclosure or substrate.

3.9 ELECTRICAL AND TELEPHONE SERVICE CONNECTIONS:

A. All provisions for electrical power service, installation at service gutter, service feeders, current transformers and metering, and main service switches will be furnished and installed under Section 26 21 00.

B. Service for telephone will be extended to the main telephone board installed under the base contract and terminated in an empty conduit strapped to the telephone board.

C. All other electrical work illustrated on the accompanying drawings and specified herein shall be included under the base contract.

3.10 TESTS:

A. On completion of the work, make voltage, resistance and ground tests of all wiring installed

under this Contract.

B. Such tests shall show results in accordance with the requirements of the Code. See specific items for other specific test requirements.

C. Any defect found shall be repaired under this Contract to the satisfaction of the Architect.

3.11 GUARANTEE:

A. Warranty all work done and all materials and equipment furnished to be free from defects.

B. Promptly repair or replace defective work, material and equipment without charge to the Owner at a schedule suitable to the Owner.

C. The warranty shall be for a period of one year after acceptance for beneficial use by the Owner unless otherwise indicated elsewhere.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install electrical wires and cables for the distribution of electric power, controls, grounding and signals for the electrical systems.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

1.3 SUBMITTALS:

A. Submit complete manufacturers' specification data on each type of conductor to be supplied to the job.

B. Include proposed colors, color markings and other identification as a part of the submittal.

1.4 QUALITY ASSURANCE:

A. Electrical conductors shall be UL listed and bear the UL label.

PART 2. PRODUCTS

2.1 CONDUCTORS;

A. Wires and cables shall have conductors of soft-drawn annealed copper having a conductivity of not less than 98% of that of pure copper. Wire and cable shall be equal to that manufactured by Anaconda.

B. Where not specifically indicated otherwise, wire and cable insulation type shall be as follows:
1. For general use - Type THHN or THWN, 600 volt.
2. For branch circuits of No. 12 and No. 10 AWG - Type THHN, 600 volt.
3. For control wiring - Type THHN 600 volts, No. 14 AWG minimum size.
4. Wiring run underground - Type THHN/THWN, or XHHW 600 Volt.
5. For fixture wiring - Type AF, 300 volts, No. 14 AWG minimum size.
6. For branch circuit wiring run in fluorescent fixture channels - Type THHN, 600 volts, No. 12 AWG minimum size.
7. See other sections of work for alarm communications and other low-energy systems wiring.
8. All communication, and low voltage control wire run in plenum above ceilings and not protected by conduit shall be teflon coated plenum cable as required by code.
9. Service and/or feeder wiring to panelboards may be XHHW at the Contractors option.

C. Wire shall be solid for No. 10 and smaller and stranded for No. 8 AWG and larger.

D. All wire and cable shall be factory-color coded. Colors for each phase and neutral shall be used consistently throughout each system. The following color codes shall be used and maintained throughout the system:

	120/208 V SYSTEMS OR 120/240 V SYSTEMS	277/480 V. SYSTEMS
Phase A	Black	Orange
Phase B	Red	Brown
Phase C	Blue	Purple
Neutral	White	Gray
Ground	Green	Green with Tracer
Switch Legs	Yellow	

On wires No. 6 and larger and where factory color is not available, wires and cables shall be color-coded by a one inch (1") wide band of colored Scotch tape on ends of each conductor, or by coating a 3" band at the end of the cable and in each pull box with brilliant waterproof lacquer.

2.2 TERMINATIONS, SPLICES AND TAPS:

A. Cable terminations, splices and taps for copper conductors shall be:
1. For Terminations - O. Z. Manufacturing Company or equal, Type XLH.
2. Splices and Taps - O. Z. Manufacturing Company or equal, clamp-type solderless connectors except splices and taps for No. 8 AWG and smaller conductors may be Scotchlock Spring Connectors, Buchanan "B" cap, Ideal Wing Nuts or T & B "Piggy" connectors.

2.3 SUPPORTS:

A. Supports for wiring in cabinets, panels, pull boxes, wireway and junction boxes shall be T & B Ty-Rap cable clamps and cable ties.

B. Supports in vertical feeders shall be two-piece conduit type equal to O. Z. Company Style "S".

PART 3. EXECUTION

3.1 CONDUCTOR SELECTION:

A. The minimum size of wire shall be No. 12 AWG except as noted otherwise on the Drawings or specified herein. All branch circuit home runs over 100 feet from panel, measured along the length of the raceway, shall be wired with No. 10 AWG minimum.

B. The Drawings and Schedules generally indicate the number of wires in a conduit. Provide the proper number of wires in each conduit to complete the entire electrical system.

3.2 INSTALLATION:

A. Route each conductor through an approved Electrical Raceway. Pull conductors into conduit only after all conduits and outlet boxes are permanently in place. Pull wires or strings shall be inserted only after the raceway installation is complete.

B. Run feeders and mains continuously without splice from line to load terminals and identify phases in each pull box and in the gutters of each switchboard and panelboard in which they connect. Splices in feeders may be made only where designated on the Drawings or where specific prior approval is given.

C. Neatly train, control and circuit wiring in cabinets, panels, pull boxes, wireways, and junction boxes and tie with T & B Ty-Rap nylon cable ties. Clamp or fasten control or circuit cabling in cabinets or other equipment with non-metallic nylon T & T Ty-Rap cable clamps and

mounting brackets.

D. Install cable supports per N.E.C. in all vertical feeders and in boxes provided for the feeders where not terminated in electrical panels or equipment within code distances. Supports shall be of the two-piece conduit type, which clamp each individual conductor firmly and tightens due to weight of cable.

3.3 TERMINATIONS, SPLICES AND TAPS:

A. Connections of conductors to terminals shall be made by pressure connections. Solder joints will be permitted only for low voltage controls. Joints and splices shall be made with clamp type solderless connectors and insulated with rubber and friction tape or Scotch No. 33 plastic tape. Spring connectors may by used for splicing No. 8 AWG or smaller conductors.

3.4 SUPPORTS:

A. Install supports to hold conductors in place in each panelboard, cabinet, pull box, junction box and wire-way.

B. Install cable supports in vertical runs of conductors in cabinets and pull boxes.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install proper grounding systems for the entire electrical installation.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

1.3 REQUIREMENTS OF REGULATORY AGENCIES:

A. Special attention is directed to Article 250 and Article 517 National Electrical Code (NFPA-70) for sizing and connecting of the grounding systems.

PART 2. PRODUCTS

2.1 MATERIALS:

A. Grounding conductors shall be green colored insulated annealed copper sized, unless specifically indicated otherwise, with an ampacity of at least 50 percent of feeder supplying the equipment to be grounded and no ground wire shall be smaller than No. 6 except, where the feeder supplying the equipment is smaller than No.6, the grounding conductor in that case shall be the same size as the feeder conductor.

B. System Ground connections shall be Burndy Type GAR or equal.

C. Cable connections shall be solderless, bolted pressure connectors.

D. A grounding conductor shall be installed in <u>every</u> conduit. All conduit, boxes, fixtures, etc. shall be bonded to the common grounding bus. At boxes provide Appleton or equal,green head, grounding screws. All fluorescent fixture ballast housings shall be securely bonded to the ground system.

PART 3. EXECUTION

3.1 INSTALLATION:

A. The common Ground Bus is defined as the main Ground Bus located within the Building Service Entrance Main. This shall be the common Ground point for all ground connections. Stray grounds to the Building frame and/or structural members will not be permitted. A separate color coded insulated grounding conductor shall be run in each and every Raceway as noted on the accompanying drawings and shown in the panel Schedules. The Grounding conductor shall be of the same insulation as the circuit conductors sized in accordance with Article 250 NEC and as illustrated on the drawings.

B. In the Lighting System, BX pigtails or Aluminum grounds will not be permitted. All such six foot fixture pigtails shall be installed in flexible Steel conduit "Greenfield" utilizing green coded copper grounding conductors. Fluorescent fixture ballasts shall be grounded by bonding jumper from the fixture frame to the ballast retaining bolt.

C. Testing

1. At the completion of the Grounding System, Meggar test all grounding to the satisfaction of the Architect and Engineer. The Ground System shall Meggar 5 OHMS or less.

END OF SECTION

SECTION 26 05 29

HANGARS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install all necessary hangers, supports, bases and connections for properly installing all electrical equipment and materials.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

PART 2. PRODUCTS

2.1 MATERIALS:

A. Provide hot-dipped galvanized malleable iron one-hole pipe straps, beam clamps, or hang-on-steel rod hangers for single runs of conduit to be fastened to the structure. Rod hangers shall be selected for weight supported but shall not be smaller than No. 8.

B. Rod hangers and adjustable "J" pipe hangers shall be equal to Kindorf Type C-149 for conduits. Conduits two inches (2") and smaller may be fastened with pipe hangers equal to Kindorf Type 6H.

C. Caddy spring steel clamps and hangers and steel one-hole snap straps may be used in lieu of above to fasten single runs of conduit up to one inch (1") size to steel structures and support rods where this conduit is run within the ceiling space.

D. Continuous channel inserts or trapeze hangers made of steel framing channel and fastened with single bolt channel pipe straps shall be provided to support multiple runs of conduit and other raceways.

E. Galvanized U-bolts or Kindorf C-210 riser pipe clamps on channel iron bearing plates at intervals of at least one clamp per joint shall be provided for support of vertical runs of conduits of more than twelve feet (12").

F. Suitable angle iron or framing channel supports shall be used to support all panelboards, cabinets, junction and pull boxes. Where indicated as not mounted to the building structure.

PART 3. EXECUTION

3.1 INSTALLATION:

A. Securely fasten and support conduits and raceways of all types and all electrical boxes, devices, and equipment from the main building structure except as specifically indicated otherwise. Support conduits within three feet (3') of each end of each bend, of each termination and at intervals along the run that will maintain true raceway alignment, without sag or deformation either during pull-in of conductors or after conductors are in place. On exposed raceways, provide supports at a minimum of six feet (6') on centers and on each side of each bend. Vertical conduits shall be supported at not more than 10' on center in addition to the above.

B. Maintain horizontal and vertical alignment of raceways so as not to adversely effect the building structure in strength or appearance. Cable, strap, or wire hangers or fasteners shall not be used.

C. Place conduits running exposed on and adjacent to walls after wall surface is installed and on spacers to allow wall to be painted after conduit is installed.

D. Support cabinets and boxes to the floor and to the structure above independent of all raceways entering the boxes. Structural walls or columns may be used to support these cabinets or boxes only after specific approval is given.

E. Fasten cabinets, boxes, panelboards, disconnects, motor controls and similar devices indicated other than at walls on channel iron racks mounted to floor and structure above. Three-fourths inch (3/4") thick plywood backboards painted to match the equipment finish may be used as a part of the rack.

F. Support outlet boxes and junction boxes 100 cubic inches and smaller as specified for raceways. Locate outlet and junction boxes above accessible ceilings so they will not interfere with the installation of a lay-in type lighting fixture in any space in the ceiling.

G. Rust inhibit all supports by galvanizing or other approved means. Supports shall be job rust inhibited at all cuts, breaks, welds, or other points where rust inhibitor coating is broken.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install complete systems of raceway and boxes for the installation of electrical systems as specifically indicated.

B. Provide complete raceway systems for each conductor of electric power, to be installed in this division of the work and for other work where so indicated except as specifically indicated otherwise.

C. Furnishing and installing of complete systems of electrical conduits as a part of the raceway systems for installation of conductors for electrical systems.

D. Furnish and install prewired multi-outlet assemblies as indicated on the plans to provide convenience power outlets.

E. Furnish and install junction and pull boxes where indicated or where necessary for installation of the wiring systems.

F. Furnish and install suitable outlet boxes for lighting fixtures, devices, empty raceway devices, small junction boxes, and other locations as required by the installation.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

B. See Section 26 05 29 for Hangars and Supports.

C. Governing codes as required by the National Electrical Code - Article 380 and 386 and all materials shall be U.L. listed and so labeled.

1.3 SUBMITTALS:

A. Submit complete information including manufacturer, material, and finish on each type of raceway and boxes to be installed.

B. Submit complete information on methods and materials for support of each type of raceway.

C. Shop Drawings shall be submitted on each specifically fabricated junction or pull box.

D. Submit Manufacturers' specification data on each type of box and trim to be furnished to the job.

1.4 QUALITY ASSURANCE:

A. Each raceway shall bear the UL Label where UL Standards have been established for the type of raceway being provided.

B. Each raceway shall be suitably protective coated for the installation and each portion of the protective coating that is damaged during receiving, handling and installation shall be refinished equal to factory protection.

PART 2. PRODUCTS

2.1 RACEWAYS

A. Materials:
1. Raceways include conduits, ducts, wireways, gutters, cable trays, boxes, fittings, and similar items as indicated in other sections of the work.
2. Raceways fabricated for special pull boxes, junction boxes, gutters, and similar connections shall be code-gauge steel fully rust inhibited and finish painted to match adjacent switch-gear. Interiors shall be accessible through screw covers. Supports and interior protection shall be provided for conductors.

B. Sleeves:
1. Sleeves shall be galvanized steel, formed to meet the size and shape of the raceway to pass through the sleeve.
2. Sleeves for conduits through exterior walls shall be galvanized steel, Schedule 40 pipe or conduit.
3. Sleeves for conduits through interior walls that are not subject to moisture may be non-metallic conduit.
4. Sleeves through waterproof walls, floors and roofs shall be provided with water-stop flanges at the point of waterproofing membrane.
5. Sleeves through waterproof floors shall be as specified for exterior walls below grade except that the collar shall be located at the level of the waterproofing membrane.
6. Sleeves through the roof shall be as specified for waterproof floors plus a galvanized iron pitch pan around the sleeve.
7. Sleeves through fire-rated construction shall be non-combustible.

C. Pitch Pans:
1. Pitch pans shall be galvanized steel pans of the shape of the raceway passing through the waterproofing membranes, of the size to provide 1" to 2" space between the outside of the raceway and the vertical side of the pan and of a depth to be set on the waterproofing membrane and extend 1" above the finished roof.

D. Smoke and Fire Stop Sealant:
1. Smoke and fire stop sealant caulk shall be 3M Company Type CP-25 and putty shall be 3M Company Type 303. Larger openings shall be stuffed with 3M Company fire barrier composite, Sheet No. CS195 in accordance with the manufacturer's directions. Silicone foam penetration sealant shall be General Electric PENSIL 851 or Dow-Corning RTV as approved for the installation.

2.2 CONDUIT AND FITTINGS

A. Rigid Metallic Conduits and Fittings:
1. Rigid metallic conduit shall be standard hot-dipped galvanized mild rigid steel. Conduit shall have galvanized threads. Each length shall be provided with a coupling and ends without couplings shall be furnished protected with a suitable covering. All bends in conduit one and one-quarter inch (1-1/4") in size and larger shall be made with factory manufactured elbows. Rigid metallic conduit shall be equal to Republic Galvite Rigid Steel Conduit.
2. Locknuts and bushing shall be galvanized steel except O. Z. Manufacturing Company Type "A", or approved equal molded canvas bakelite bushings may be used for 2" trade size and O. Z. Type "B" bakelite insulated, lined steel bushings may be used for conduits two and one-half inches (2-1/2") and larger.

B. Intermediate Metallic Conduit (IMC.):
1. Intermediate metal conduit shall be hot-dipped galvanized steel tubing with galvanized threads equal to IMC manufactured by Allied Tube and Conduit

Corporation.

2. Fittings and accessories shall be the same as set forth for rigid metallic conduit.

C. Electrical Metallic Tubing and Fittings:

1. Electrical metallic tubing shall be standard galvanized EMT equal to Republic Electrinite E.M.T.
2. Couplings and connectors for EMT shall be T & B or equal, steel compression type with steel gland nuts. Connectors shall be uninsulated throat type. Cast metal, set screw or indentor fittings are prohibited.

D. Flexible Metal Conduit and Fittings:

1. Flexible metal conduit shall be Triangle Conduit and Cable Company or equal, spirally wound galvanized steel.
2. Terminators of flexible steel conduit shall be T & B or equal "Tite-Bite" insulated connectors and T & B or equal, "Tite-Bite" combination couplings.

E. Liquidtight Flexible Metallic Conduit and Fittings:

1. Liquidtight flexible metal conduit shall be equal to American Brass "Sealtite" Type UA, light grey color.
2. Terminators shall be T & B or equal, insulated throat screw-in ground cone connectors.

F. Special Fittings:

1. Split couplings shall be O.Z. or equal, Manufacturing Company Type SP.
2. Expansion joints shall be O.Z. or equal, Manufacturing Company Type AX expansion joints with Type AJ bonding jumpers.
3. Pull rope shall be 3/16" polyester stranded JET LINE rope.

G. Rigid Pvc Conduits and Fittings:

1. Codes and standards shall conform with U.L.-651 and NEMA TC-2 and shall be listed and labeled by the Underwriters Laboratories Inc.
2. PVC conduit and fittings shall be equal to Carlon "Plus 40" systems. They shall be designed for use under ground, shall be non-conductive and shall assure a safe system. Conduits and fittings shall be non-corrosive, impervious to most chemicals, provide lower expansion and contraction features, and shall be suitable for direct earth burial or encasement in concrete.
3. PVC conduit and fittings shall be rated for 90 degree centigrade conductors or cable, and for use in direct sunlight.

H. Rigid PVC Fittings:

1. Codes applicable to PVC conduit shall also apply to PVC Fittings.
    a. Expansion couplings equal to Carlon E945 or E955 as required.
    b. Bell ends equal to Plus 80 or 40 plain bell for use with non-metallic solvent welds.
    c. Standard couplings socket type for solvent cement attachment.
    d. PVC rigid adaptors E942 or E943 threaded to metallic systems and socket attachment by solvent cement.

2.3 SURFACE METAL RACEWAY:

A. Materials:

1. Furnish and install Wiremold or equal, two piece surface metal raceway consisting of base and cover 2000 wiremold series with grounding type duplex receptacles, 4-wire, or as indicated on drawings.
2. Assembly shall include as required any wire cups, support clips, ground clamps, entrance fittings, blank end fittings, elisons, and necessary receptacles.
3. Factor fabricated sections shall be pre-punched C.R. steel, receptacle hole cuts on

9" center-to-center. Where installed at back bars, covers and bases shall be stainless steel.

4. Surface metal raceways installed at back bars, damp locations, etc., shall be wired utilizing ground fault circuit interrupting circuit breakers. Reference panelboard schedules.
5. The following manufacturers are acceptable under this specification:
   a. The Wiremold Company, West Hartford, CT

2.4 JUNCTION AND PULL BOXES:

A. Materials:

1. Junction and pull boxes shall be flush or surface type as indicated on the drawings or as required to fit into the building construction. Junction and pull boxes shall have screw covers. Small junction boxes,100 cubic inches and smaller, for control or branch circuit wiring, shall be as specified for outlet boxes and with blank covers.
2. Junction and pull boxes installed in walls and ceiling spaces shall be code-gauge galvanized steel with galvanized steel covers.
3. Junction and pull boxes installed in floors shall be galvanized malleable cast iron with gasketed covers.
4. Junction and pull boxes installed outdoors shall be weatherproof with watertight gasketed covers fastened with corrosion resistant screws.
5. Except as otherwise indicated, boxes shall be not less than code requirements and their size shall be determined as follows:
   a. For straight pulls involving conductors of No. 6 or larger and for raceways of 1-1/4" and larger, the length shall be a minimum of 8 times the diameter of the largest raceway, and the width shall be three (3) times the diameter of the largest raceway plus the sum of the diameters of all other raceways in the same side of box or cabinet.
   b. For angle pulls or direction changes, the distance between any entering raceway and the opposite side of box shall be a minimum distance of six (6) times the diameter of the largest raceway and the minimum distance between raceway entries enclosing the same conductor shall not be less than 6 times the diameter of the larger raceway. Additional raceways in the same wall of the box shall require increase of these dimensions by the sum of the diameters of the added raceways. In no event shall any cabinet or box contain more than 20% of its' cross sectional area in conductors. Where conductors cross a box, a maximum of nine (9) conductors may be laid parallel without the use of a barrier or compartment. Where junction or pull boxes involve dimensions over 36 inches on any side, conductors crossing such distances must be supported on approved racks or clamps in such a manner as to avoid greater unsupported spans of more than 36 inches. Where such boxes exceed 60 inches in any dimension, all conductors shall be so supported regardless of direction of travel.

2.5 OUTLET BOXES:

A Materials:

1. Outlet boxes, except where otherwise specifically indicated or required, shall be of one-piece or welded assembly construction. Outlet boxes shall be with covers of the same manufacture as the box and selected to meet the conditions of the installation.
2. Outlet boxes shall be equal to the following Appleton types except that where more conduits enter the boxes, structural conditions interfere, or wiring requires more space,larger boxes of similar construction shall be used. Multi-gang boxes for switches of different voltages shall be provided with interior barriers.
   a. In dry walls for single and two-gang outlets, Type 4S and 4SD with No. 846 and 847 covers not more than 1" high and boxes specified for masonry for 3 or more gangs. Where boxes serve one wiring device a single gang handy

box may be used.

b. In concrete block or similar masonry walls, No. M1-250, M2-250 or M3-250 for 1, 2 and 3 gang outlets in 4" thick walls, No. M1-350 for 1, 2 and 3 gang outlets in thicker walls and the same series for more gangs in common boxes in similar walls.

c. In poured concrete, plaster and similar masonry walls, No. 4S and 4SD boxes with No. 846 covers for single gang outlets, No. 2G-5075 boxes with No. 2GC-75 covers for 2 gang outlets and corresponding G-5075 boxes and G C-75 covers for 3, 4, 5 and 6 gang outlets. Covers shall be maximum of 1" high.

d. In concrete ceilings, Type O C R boxes and O C P covers.

e. In other ceilings, Type 4/0 and 4/0D boxes. Outlet boxes for surface or pendant lighting fixtures shall have 3/8" fixture studs.

f. In poured concrete floors, Steel City 600 Series cast iron, watertight, fully adjustable with threaded conduit openings, expandable cap to prevent ingress of concrete during pour, carpet or tile plate and P-60-DR duplex lift lid with steel seating plate for receptacle.

3. Exposed outlet boxes mounted in protected areas shall be solid gang switch boxes with flat covers. Boxes shall be of size and number or gang for device requirements except no box shall be smaller than 4" square.

4. Outlet boxes exposed on exteriors of buildings, flush in non-waterproofed walls below grade or in wet locations shall be Type FS or FD threaded outlet cast boxes with suitable gasketed cast covers.

5. Small junction boxes shall be the same as device boxes except shall be provided with blank plates.

PART 3. EXECUTION

3.1 RACEWAYS:

A. Installation:

1. Each raceway shall be suitably supported from, installed and aligned with the main structural components of the building.

2. Raceways shall be installed to avoid interference with work of other trades.

B. Protection and Cleaning:

1. Raceways will be cleaned both internally and externally of all dirt, debris, and other foreign materials. Raceways in areas to be finish-painted shall be cleaned properly prior to the painting. Raceways not indicated to be finish painted on the job shall be protected from foreign objects and materials during construction and cleaned and touch-up coated before completion of the work.

C Sleeves and Openings:

1. Furnish and install sleeves in forms of walls, floor slabs, partitions and beams for the passage of raceways. Sleeves shall be securely fastened in position and trimmed to be flush with construction.

2. Conduits in above grade outside walls shall be installed in the center of sleeves and the annular space filled with Oakum and sealed with asphalt. Sleeves through interior walls shall be filled with wall-sealing material. Raceways passing through sleeves shall be fitted on each side of each interior wall with a round galvanized steel flange. Raceways that pass through waterproofed walls shall be sealed to forbid water passing through the conduit.

3. Route wireways, and/or groups of conduits which pass through floors or interior walls through blocked-out openings. After installation of raceways, fill the entire blocked-out area with material compatible with the floor or wall penetrated before finishing treatment is applied. Where fire and/or smoke-rated construction is penetrated, penetrations shall be sealed in accordance with sealant manufacturer's

instructions. The completed installation shall maintain the fire-rating integrity of the construction.

4. Furnish and install and coordinate with the Installer of the roof to provide pitch pans for all small raceways and curbed openings with flashing and counter flashing for large Division 16 Work passing through the roof.

3.2 CONDUITS AND FITTINGS

A. Material Selection:

1. Raceways shall be standard galvanized steel rigid metal conduit unless otherwise indicated.
2. Intermediate metal conduit (IMC) may be used wherever rigid conduit is required except for raceways embedded in concrete slabs, in contact with the earth, underground not encased in concrete and in corrosive locations.
3. Aluminum rigid metal conduit may be used wherever rigid conduit is required except embedded in concrete slabs or underground.
4. Electrical Metallic Tubing (EMT) may be used for raceways above furred ceilings, within dry wall partitions, exposed in rooms with exposed construction and in mechanical and electrical rooms for sizes of four inch (4") and smaller.
5. Wiring connections to motors, transformers, or other devices which are subject to vibration or require adjustment shall be flexible metallic conduit. The flexible conduit shall be more than 12 diameters but less than 18 diameters in length. Where these connections are outdoors, or in damp locations, or are connections to any kitchen or laundry type equipment, liquid-tight flexible conduit shall be used.
6. Wiring to each recessed lighting fixture shall be run in an independent length of flexible conduit extended from an accessible junction box located above the ceiling. The flexible conduit shall be of sufficient length to allow the connection point to the fixture to drop at least 12" below the finished ceiling, and shall be at least 48"long but not more than 72" long. Recessed lighting fixtures which have UL approved prewired circuit junction boxes and fixture wire extensions may be used and wired directly to the branch circuit runs without the added flexible conduit connections.
7. Elbows shall be of the same materials as the conduit. Elbows in EMT and small rigid conduits may be job-fabricated with a bender made specifically for the purpose.
8. Conduits shall be sized as indicated on the drawings and as required to accommodate the wires to be pulled into the conduit. Conduit shall not be less than three-quarters inch (3/4") in size except EMT for branch circuit runs may be one-half inch (1/2") and three-eighths inch (3/8") flexible metallic conduit may be used for individual connections to recessed lighting fixtures.

B. Conduit:

1. Run conduits concealed from view in all areas except in electrical and mechanical equipment rooms. Run at levels and locations to avoid interference with the structure, finished ceilings, walls and all lines of other trades requiring grading of runs. Coordinate with other trades to allow available spaces to be used in the most efficient and workman like manner. In general, space and routing requirements of all other trades shall take precedence over the conduit installation.
2. Route exposed conduits parallel with or at right angles to building walls and neatly rack. Carefully lay out conduit proposed to be run within the structure such as floors, beams, roof, or walls to avoid building up the density of conduits too excessive for the construction. Relocate conduits when excessive build-up occurs.
3. Install conduits out of close proximity to any potentially hot device, any steam pipe, hot water pipe or other heating duct or appliance. Conduit shall not be run within three inches (3") of the exterior insulation of such device, pipe or duct, except in crossing, and such crossing shall be at least one inch (1") from the cover of the device, pipe or duct crossed.
4. Place conduits through the roof or exterior walls in time to allow the trade to seal around the raceways as work is installed. Conduits through roof shall run through

galvanized pitch pans.

5. Cover each end of each conduit with an approved capped bushing as soon as the conduit is installed to prevent entry of foreign material. Conduits shall be dry and clean before wires are pulled.
6. Locate junction boxes and raceways above accessible ceilings such as lay-in ceiling to provide adequate space for recessed fluorescent fixtures of the type specified elsewhere to be installed, in any place in the ceiling without relocating the installed raceways, boxes or supports now or in the future.
7. Arrange conduit runs within building interiors to be no longer than 80 feet between pull or junction boxes, cabinets, or circuit interrupting device enclosures unless there is no direction change and only a straight-in-line pull of wire is involved. In such straight-in-line runs between boxes, cabinets or devices, runs not exceeding 100 feet in length may be made.
8. Non-Metallic conduit installed outdoors under concrete slabs or walkways shall have 24 inches cover and may be in contact with the earth. Conduit service laterals installed under driveways, or roadways shall be concrete encased. Support runs on PVC spacers 5'- 0" center-to-center and encase in reinforced concrete duct banks. Reinforcing shall be #4 deformed longitudinal bars, one each corner, with #3 stirrups tied at 1'- 0" reinforcing concrete shall cover bar minimum 2 inches around each corner face. Non-metallic conduit installed indoors shall have 12 inches cover.

C. Fittings:

1. Install double locknuts and a bushing at each rigid conduit termination except for terminations into threaded hubs.
2. Wherever standard threaded couplings cannot be used, split couplings may be used.
3. Provide expansion joints in conduits at all building expansion joints and wherever else the length of run requires.
4. Coat all threaded connections subject to moisture or under ground with cold galvanizing before making connection up.

D. Pull Rope:

1. Install a pull rope with each end properly marked for use and termination of the other end in each conduit installed and in which no conductors are installed under this Division of Work.

3.3 SURFACE METAL RACEWAY:

A. INSTALLATION:

1. Set in place and plumb all raceway bases as illustrated on the electrical plans and/or detailed on architectural drawings.
2. Furnish with the raceway and install all fittings, supports, clips, wire straps, end fittings, and conduit entry fittings as required for a complete and satisfactory installation.
3. Furnish, install, and make ready for operation all receptacles and outlets.
4. Install all covers to leave the installation complete and in working order.

3.4 JUNCTION AND PULL BOXES:

A. Installation:

1. Install junction and pull boxes in a neat workmanlike manner and support in accord with the provisions set forth elsewhere for panelboards and for hangers and supports.
2. Arrange for raceways to enter boxes only in places specifically planned for raceways in the sizing and construction of the cabinets.
3. Provide auxiliary conductor supports in large boxes per N.E.C. 314 where conductors must be supported.

B. Labeling:

1. Conductors passing through the boxes shall be marked as to phase.

3.5 OUTLET BOXES:

A. MATERIAL SELECTION:

1. Outlet boxes shall be of the standard stamped galvanized steel type except for exterior use where they shall be hot-dipped galvanized cast iron with gaskets. Boxes shall be of the proper size to accommodate the wiring and device for which they are provided.
2. Ceiling outlet boxes shall generally be four inches (4") octagon, and wall outlet boxes shall switch boxes or be 4" square with covers to suit device to be mounted thereon, except that in masonry walls without applied finish, boxes shall be rectangular masonry boxes.
3. Through-the-wall type boxes shall not be used.

B. INSTALLATION:

1. Install and leave boxes in a neat, clean and workman like manner. Set plaster covers to within 1/8" of the finished surface.
2. Determine exact locations of all outlets from the Architectural Scale Drawings or at the site by the Owner. Modify outlet locations from those shown on the Drawings to accommodate door swings or to fit other construction details without cost to the Owner. Set wall boxes in advance of wall construction and move where required for any outlets which are displaced during the operation of other trades without expense to the Owner.
3. Unless noted otherwise on the Drawings, indicated on Architect's Drawings, or directed by the Architect at time of installation, place outlet boxes at the locations scaled from the floor plans and at the following heights to the center of box above the finished floor level:
   a. Wall Switches: 48" and immediately adjacent to strike side of door.
   b. Convenience Receptacles: 15" vertically oriented except 23" for E W C's and horizontally oriented and 4" above backsplash or trim when indicated above counters.
   c. Telephone Outlets: Unless indicated otherwise 15" vertically oriented except they shall be 48" for wall phones and horizontally oriented and 4" above backsplash or trim when indicated above counters.
   d. Wall Bracket Outlets: 78"
4. Each recessed lighting fixture shall be independently connected from an above ceiling junction box which is readily accessible through the lighting fixture opening.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1. GENERAL:

1.1 WORK INCLUDED:

A. Furnish and install panelboards as indicated.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

B. See Section 26 28 16 for Circuit Breakers.

B. See Section 26 05 29 for Hangars and Supports.

1.3 SUBMITTALS:

A. Submit complete manufacturer's specification data on each type of panelboard including manufacturer and type, proposed to be furnished.

B. Submit a complete description and listing of devices proposed for each existing panelboard.

PART 2. PRODUCTS

2.1 DEVICES:

A. Distribution panelboards shall be General Electric Type CCB; Square D Type I-Line; or Westinghouse Type CDP circuit breaker type. Fusible switch distribution panelboards shall be General Electric Type QMR; Square D Type QMB or Westinghouse Type FDP. Main and branch devices shall be as scheduled on the drawings and shall have interrupting ratings adequate to interrupt the fault current available.

B. Panelboards as manufactured by G.E., Square `D', Westinghouse or Siemens are acceptable.

PART 3. EXECUTION

3.1 INSTALLATION:

A. Install circuit breakers in accordance with manufacturer's published instructions.

B. Arrange for raceways and conductors to enter panelboards only in factory recommended locations and to avoid excessive build-up of conductors in any area of the cabinets.

C. Conductors shall be trained to their points of connection, labeled with their circuit numbers, and bound securely with ties between the lug connections and the raceway entries to the panelboard.

D. Install spare conduits from each panelboard. Where ceiling above is furred down, stub three 3/4" conduits from each panel to an accessible space above the ceiling. Where ceiling is exposed, stub three 3/4" conduits up and turn out at the ceiling. Where there is ceiling space or crawl space below, stub three 3/4" conduits to below in a similar manner.

3.2 LABELING:

A. Provide a neatly, typewritten directory of circuits for each panelboard as indicated on panel schedules.

END OF SECTION

SECTION 26 27 13

ELECTRICITY METERING

PART 1. GENERAL

1.1 WORK INCLUDED

A. Any required outside work shall be in accordance with utility standards.

1.2 REFERENCE DOCUMENTS

A. The special provisions for electrical work and underground services are hereby made a part of this section of the work. Refer to Section 26 00 00 and Section 26 21 16.

PART 2. PRODUCTS

A. The Electrical service will be a combined 208 Wye; 120 volt, 3-phase, 4-wire, 60 Hertz Service for power and lighting.

B. Metering will be accomplished through metering equipment furnished and installed by the Utilities Company in accordance with the latest standards for electric service as published by the Utilities Company.

C. The Utility Company will make available to the Electric Contractor drawings and standards for any required enclosure for metering. The electrical contractor shall secure said enclosure together with installation instructions and shall furnish all labor, material, and tools to properly install the enclosure as directed by the utility company. Furnish all conduit, supports, etc. required for a complete and workable utility approved installation.

D. The Utility Company upon approval of the installation will install current transformers and a suitable meter where all electrical power consuming devices will be measured.

E. The building panelboards may be utilized for temporary construction power once metering is established by the local Utility Company.

F. At the end of the construction period, all equipment shall be restored for permanent building use.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install wiring devices and cover plates of the type and kind as hereinafter indicated on the drawings.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

1.3 SUBMITTALS:

A. Submit complete manufacturer's specification data on each wiring device proposed to be furnished to the job.

1.4 QUALITY ASSURANCE:

A. Each wiring device shall be of design, type and configuration established by NEMA Standards for the application used.

PART 2. PRODUCTS

2.1 MATERIALS:

A. Devices shall be Specification grade, UL and CSA certified, listed NEMA Standard, and suitable for the service required in the intended use of the device in this installation.

B. Where devices manufactured by Arrow Hart, Bryant, Hubbell, P & S Leviton, or Sierra are named, only equivalent devices by the other of these manufacturers will be acceptable. Unless otherwise indicated, devices shall be as follows:

1. Wall Switches: 20 ampere, 120/277 volt AC, P & S No. 501-I, 502-I, 503-I and 504-I for single pole, double pole, three-way and four-way respectively.
2. Pilot Lighted Switches: 20 Ampere, 120/277 Volt AC, P&S No. 20AC1-RPL, 20AC1-RPL and 20AC3-RPL for single pole, double pole and three-way respectively with red handle (glow when "on").
3. Convenience Outlets: Duplex receptacles P&S 5362-1 20 Ampere, 125 Volts side and back wired with a pair of NEMA 5-20R Standard 3 contact grounded parallel slot contacts. Ivory finish in light colored walls, brown finish in dark colored walls, or as designated by the Architect.
4. Convenience outlets designated as suspended from ceiling outlet boxes on flexible rubber cord: P&S Flexcor wire mesh holding grips sized to the cable with NEMA L5-20-C Locking connectors.
5. Isolated Ground receptacles at cash register or computer Hubbell No. 5261 "Orange" Simplex NEMA 5-15R. 3 contact Grounded parallel slot contacts. Provide matching "Orange" cover plate labeled "Isolated Ground".
6. Ground Fault Circuit Interrupter Convenience Outlets: P&S No. 2091-S-I side wired 120 Volt with appropriate wall plate.
7. Weather proof convenience outlets: P&S 1591-WP cover, hinge pins, springs and screws stainless steel with gasketed cover.
8. Welding outlets and special equipment outlets shall be furnished and installed to match the connecting plugs as provided by the Owner on specialized equipment provided.

9. Convenience Outlets: 20 Ampere, 250 Volt rating side wired NEMA 6-20R P&S No. 5851-I.
10. Manual Motor Starters Square D Class 2510 with overload heater sized to the motor nameplate rating.
11. Photocopy Machine: P&S 5631-I NEMA 5-20R, 3 contact grounded parallel slot contact, with appropriate cover plate.
12. Flush floor outlets shall be Hubbell or equal, B2537 shallow floor box semi-adjustable with S-3725 brass duplex screw cover and NEMA 5-20R receptacle.
13. Other receptacles: Other receptacles shall be of type and characteristics and NEMA configuration to provide service as indicated for the special service as indicated elsewhere.

C. COVERPLATES:
1. General: Opening in Plates shall properly fit the wiring Devices associated with the outlets. Plates shall overlap outlet box edges for installation over finished room surfaces and shall be the non-over hanging type to fit condulet boxes used with exposed conduit runs. All plates shall be smooth, ivory plastic coverplates with matching screws unless designated by architect.
2. Telephone outlet: One hole plate with 5/8" bushed opening 302 stainless steel designed for the purpose intended.
3. Future or abandoned outlet: Smooth ivory plastic coverplates with matching screws.
4. Offices and Finished spaces: Smooth ivory plastic coverplates with matching screws.
5. Surface outlets in mechanical spaces standard steel device covers.
6. Outlets Installed in backsplashes and/or counter height Sierra 302 Stainless Steel.
7. Outlets installed in food preparation areas, food service counters, backsplashes, etc. shall be 302 stainless steel.

PART 3. EXECUTION

3.1 INSTALLATION:

A. Each device shall be suitable for the type of service for which it is installed. Device shall be of NEMA configuration and of Specification Grade and/or Hospital Grade for those services to which the device is installed where those standards are established. Devices indicated adjacent to each other shall be in the same box and set under a common plate. Suitable barriers shall be provided in the box for separation of each device from adjacent devices where required by code.

B. Install suitable cover plates on all wiring devices.

C. Device colors shall be Ivory unless selected and installed to match the decor of the occupancy and other standard colors as set forth elsewhere in these contract documents or as selected by the Owner. Other colors shall be provided when so directed by the Owner.

D. Wire all devices with proper polarity and suitably grounded. Provide Appleton or equal SCR 1032 PTL1 green head grounds screw and 6 inch pigtail in every box.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install all fuses in each device furnished under Division 26 and as indicated otherwise that are necessary during construction and testing and deliver the system complete with new fuses in good working condition.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

1.3 SUBMITTALS:

A. Submit complete manufacturers' specification on each application and each type of fuse proposed to be furnished to the job.

B. Include a listing of the device in which each type and size of fuse is to be mounted.

PART 2. PRODUCTS

2.1 MATERIALS:

A. All fuses shall be Bussman or equal except where specifically indicated otherwise.

B. Fuses for motor loads shall be Bussmann LPN-RK or LPS-RK UL Class RK1. Size for factory recommended protection unless otherwise indicated.

C. Fuses on lighting loads shall be Bussmann KTN-R or KTS-R UL Class RK1.

D. Equal fuses as manufactured by Gould Shawmut & Little-Fuse will be acceptable in lieu of Bussmann fuses.

E. Other fuses shall be of type and design specifically required for the protection needed.

PART 3. EXECUTION

3.1 INSTALLATION:

A. Install a new fuse in each fuse holder installed on the project of the size and voltage indicated on the drawings or elsewhere herein and of the type required.

B. Furnish one (1) complete duplicate spare fuse in original carton for each fuse installed; except that no more than ten (10) of any type and size of spare fuse need be furnished. These spare fuses shall be furnished to the Owner at the time of final inspection, in a single container and accompanied with a letter of transmittal and a list of type and quantity of fuses furnished.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install a suitable disconnect switch where indicated on the Drawings, or where required by the Specifications or the Code.

B. Furnish and install circuit breakers as indicated.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

1.3 SUBMITTALS:

A. Submit complete manufacturer's specification on each disconnect switch and circuit breaker, including manufacturer, trip and type, proposed to be furnished to the job.

1.4 QUALITY ASSURANCE:

A. Circuit breakers shall be listed by Underwriter's Laboratories, Inc., UL-50-1974 UL-67-1979, for the service to be performed and shall bear the UL label.

B. Circuit breakers shall be constructed in accordance with the applicable NEMA PB1-1977 Standards for panelboard construction.

PART 2. PRODUCTS

2.1 DISCONNECT SWITCHES:

A. Materials:
1. Disconnect switches serving motor loads shall be properly NEMA rated for these motors. Disconnects shall be environmentally rated for the area where located with NEMA rain-tight construction for units located outdoors.
2. Disconnects shall be Square D Company NEMA Type HD, quick-make, quick-break. Disconnects shall be fused type where so indicated.
3. Where shown on the Plans, Furnish and Install Class "R" rejection type Fuse clips within the Designated Device.
4. Disconnect switches shall conform to U.L. 98-1981 and shall be so labeled.

2.2 CIRCUIT BREAKERS:

A. Devices:
1. Circuit breakers shall have overload tripping in each pole. Multi-pole breakers shall open all poles simultaneously on manual operation and overload of any pole. Circuit breakers shall have magnetic arc blowout coils and shall be trip free and trip indicating with quick-make, quick-break mechanism.
2. Circuit breakers shall be provided with high pressure type solderless lugs of the proper size and type to accept the feeder cables.
3. Branch panelboards on 208/120V or 230/115V systems shall be equipped with G.E. Type THQB; Square D Type QOB; or Westinghouse Type BAB bolt-in circuit breakers with a minimum interrupting capacity of 10,000 amperes RMS symmetrical on 120VAC, 60 Hertz. Where indicated on panelboard schedules higher interrupting capacities shall be furnished.

4. Branch panelboards on 480/277V systems shall be equipped with G.E. Type TED; Square D Type NEHB; or Westinghouse Type EHD bolt-in circuit breakers with a minimum interrupting capacity of 14,000 amperes RMS Symmetrical on 277 VAC, 60 Hertz. Where indicated on panelboard schedules higher interrupting capacities shall be furnished.
5. Circuit breaker main shall be General Electric Type CCB; Square D Type I-Line; or Westinghouse Type CDP circuit breaker type.
6. Main and branch devices shall be as scheduled on the drawings and shall have interrupting ratings adequate to interrupt the fault current available.

PART 3. EXECUTION

3.1 DISCONNECT SWITCHES:

A. Installation:
1. Install disconnects for motors, controllers, transformers, electric heaters and all other devices where so indicated, specified or required by code where manual operating branch circuit protection devices are not within sight and within 50 feet of the device.
2. Mount disconnects 48" up on walls, columns or free standing rigid steel frame unless otherwise indicated.
3. Where equipment is furnished to the job with a suitable disconnect as a part of the equipment an additional disconnect will not be required to be added at the equipment.
4. Provide proper selection and sized fuses where disconnects are indicated to be fused.

3.2 CIRCUIT BREAKERS

A. INSTALLATION:

1. Install circuit breakers in accordance with manufacturer's published instructions.

END OF SECTION

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install all wiring necessary to completely connect all motors, electric powered equipment and electric controlled equipment that is furnished by the Owner, other Contractors, or the Divisions of Work. This includes HVAC equipment, plumbing equipment, fire protection, and similar items that are installed by others.

B. The Owner, other Contractors, or other Divisions of the Work will furnish locations of equipment and all instructions and wiring diagrams necessary to select the materials required to install this equipment properly. Furnish and install all conduit wire boxes and common wiring materials to make the installation complete and operative.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this section of the work. Refer to Section 26 00 00.

B. Refer to other Divisions of the Drawings and Specifications for information as to the scope of this work. All notations for electrical work to be "By Electrical" or "By Mechanical" or "See Electrical" or "See Mechanical" shall be deemed instructions for work in Division 26 00 00.

PART 2. PRODUCTS

2.1 MATERIALS:

A. The Owner or other Contractors will furnish and deliver to the job site the motors, controllers, switches, and other controls for the equipment which they furnish except as indicated otherwise.

B. Motor controllers shall be in accordance with NEMA standards for the application; a product of a NEMA member; NEMA rated for voltage, frequency and power of the motor; housed in a NEMA standard enclosure suitable for the environment of controller location; and equipped with necessary auxiliary contacts required for control and/or interlock to operate in the systems indicated. Each controller shall be equipped with an overload in each ungrounded leg selected on the nameplate full load current of the actual motor installed on the job that the device serves.

C. Except as indicated otherwise, controllers for three phase and large single phase motors shall be magnetic, non-reversing, full voltage, across-the-line type. Combination units shall have fused switch disconnects. Manual starters shall be used for small single phase motors and shall be flush mounted toggle switch type, trip free and trip indicating with neon pilot lights and Type 304 stainless steel cover plates.

D. Each magnetic starter unit shall be provided with a fused 120 volt control transformer sized to handle the holding coil, pilots, etc., plus the requirements for relays, EP switches, interlocks, remote pilots and other devices as set forth for the temperature controls and operation control. Each magnetic starter unit shall be equipped as required with a hand-off-automatic switch and pilot light or a push button and pilot light, and all necessary interlocks as required to operate the equipment served by the unit and the auxiliaries and control and indication devices associated with this equipment. Pilot lights may be omitted on intermittent operating equipment such as sump pumps and sewage ejectors, but hand-off-automatic switches on these types of devices on all equipment which could be damaged by being left in the "hand"

position shall be spring return from the "hand" to the "off" position.

E. Motor controllers for reduced voltage or increment winding starting shall be as specified for the particular piece of equipment controlled. Each such controller shall match the motor and shall be equipped with proper overload protection for the device and the motor windings, a proper timer for the first step, and shall be closed transition between steps.

PART 3. EXECUTION

3.1 INSTALLATION:

A. Set in place all controllers, switches, and control devices. Furnish and install all supports, conduit, wire, boxes and common wiring materials, etc., as required. Furnish and install all interlocks and interconnecting wiring for equipment controls and safeties and make all other electrical connections for proper operation.

B. Furnish and install a suitable disconnect switch for each motor and electric powered equipment which does not have such a disconnect as an integral part of the equipment or which is not within sight of a feeding ranch circuit protective device which meets the requirements of a disconnect.

END OF SECTION

SECTION 26 32 13

ENGINE GENERATORS

PART 1. GENERAL

1.1 SCOPE:

A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic controls.

B. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.

C. The generator set manufacturer shall warrant all equipment provided under this section so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.2 CODES AND STANDARDS:

A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.
1. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
2. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
3. NFPA37 –
4. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
5. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 2 systems.

B. The generator set and supplied accessories shall meet the requirements of the following standards:
1. NEMA MG1-1998 Part 32. Alternator shall comply with the requirements of this standard.
2. UL1236 – Battery Chargers
3. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

C. The control system for the generator set shall comply with the following requirements.
1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
4. FCC Part 15, Subpart B.
5. IEC8528 part 4. Control Systems for Generator Sets
6. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
8. UL1236 –Battery Chargers.

1.3 ACCEPTABLE MANUFACTURERS:

A. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on microprocessor-based generator sets manufactured by Cummins Power Generation.

PART 2. PRODUCTS

2.1 GENERATOR SET:

A. Ratings
1. The generator set shall operate at 1800 rpm and at a voltage of: 120/208 Volts AC, Three phase, 4-wire, 60 hertz.
2. The generator set shall be rated at 20 kW, 25 kVA at 0.8 PF, standby rating, based on site conditions of : Altitude 1000ft, ambient temperatures up to 104 degrees F.
3. The generator set rating shall be based on emergency/standby service.

B. Performance
1. Voltage regulation shall be plus or minus 1.0 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 1.0 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Motor starting capability shall be a minimum of 84 kVA. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic.

C. Construction
1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections
1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.2 ENGINE AND ENGINE EQUIPMENT:

A. The engine shall be natural gas fueled, radiator and fan cooled. Minimum displacement shall be 181 cubic inches, with 4 cylinders. The horsepower rating of the engine at it's minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Engine accessories and features shall include:

B. Complete engine fuel system, including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set.

C. Skid-mounted radiator and cooling system rated for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H_2O external static head. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.

D. Electric starter(s) capable of three complete cranking cycles without overheating.

E. Positive displacement, mechanical, full pressure, lubrication oil pump.

F. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

G. Replaceable dry element air cleaner with restriction indicator.

H. Flexible fuel lines.

I. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.

J. Coolant heater
   1. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
   2. The coolant heater shall be installed on the engine with high temperature silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
   3. The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
   4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

K. Provide vibration isolators, pad type or as recommended by the manufacturer, quantity as recommended by the generator set manufacturer.

L. Starting and Control Battery shall be calcium/lead antimony type, 12 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.

M. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

N. Provide a minimum 10 amp battery charger. The charger(s) shall include the following capabilities:

1. Chargers shall be UL 1236-BBHH listed and CSA or CUL certified for use in emergency applications.
2. The charger shall be compliant with UL991 requirements for vibration resistance.
3. The charger shall comply with the requirements of EN61000-4-5 for voltage surge resistance; EN50082-2 for immunity; EN61000-4-2 for ESD; EN61000-4-3 for radiated immunity; ANSI/IEEE C62.41 category B and IN61000-4-4 for electrically fast transient; EN61000-4-6 for conducted emissions; and FCC Part 15 Class A for radiated emissions.
4. The charger shall be capable of charging a fully discharged battery without damage to the charger. It shall be capable of returning a fully discharged battery to fully charged condition within 36 hours. The charger shall be UL-labeled with the maximum battery amp-hour rating that can be recharged within 36 hours.
5. The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to maintain a fully charge battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.
6. The DC output voltage regulation shall be within plus or minus 1%. The DC output ripple current shall not exceed 1 amp at rated output current level.
7. The charger shall include the following features:
    a. Two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and to perform programming.
    b. LED indicating lamp(s) to indicating normal charging condition (green), equalize charge state (amber), and fault condition (red).
    c. AC input overcurrent, over voltage, and undervoltage protection.
    d. DC output overcurrent protection.
    e. Alarm output relay.
    f. Corrosion resistant aluminum enclosure.

2.3 AC GENERATOR:

A. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade.

B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase

or three phase fault at approximately 300% of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

E. The alternator shall be capable of operation with reverse kVAR of 0.15 per unit.

2.4 GENERATOR SET CONTROL:

A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set.

B. The control panel shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control panel shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

C. The generator set standard operator control panel shall include the following features and functions:
   1. Control Switches
      a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the START position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
   2. Switch Indicator
      a. The switch indicator will indicate that the generator set is running by a constant on indication.
      b. If there is a generator set fault, the indicator light will flash.
   3. Total Hours Meter.
      a. The hour meter shall display the total hours of the generator set operation.

2.5 OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET:

A. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

B. Outdoor Weather-Protective Enclosure
   1. The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required

to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

2. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
3. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
4. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
5. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.

PART 3. OPERATION:

3.1 SEQUENCE OF OPERATION:

A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control.

B. The generator set shall complete a time delay start period as programmed into the control.

C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
   1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.
   2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.
   3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

D. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.

E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

1. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

PART 4. OTHER REQUIREMENTS:

4.1 SUBMITTALS:

A. Within 10 days after award of contract, provide six sets of the following information for review:
1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
3. Manufacturer's certification of prototype testing.
4. Manufacturer's published warranty documents.
5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
7. Manufacturer's installation instructions.

4.2 FACTORY TESTING:

A. The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

B. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks notice for testing.

C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

4.3 INSTALLATION:

A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.

D. Equipment shall be initially started and operated by representatives of the manufacturer.

E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

4.4 ON-SITE ACCEPTANCE TEST:

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer. The Engineer shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

4.5 TRAINING:

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

4.6 SERVICE AND SUPPORT:

A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

4.7 WARRANTY:

A. The generator set and associated equipment shall be warranted for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION

SECTION 26 36 00

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SCOPE:

A. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, AC powered operator, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

B. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided. Technicians specifically trained, tested and certified to support the product, and employed by the generator set supplier, shall service the transfer switches.

1.2 CODES AND STANDARDS:

A. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:
1. CSA 282, Emergency Electrical Power Supply for Buildings
2. IBC2006 – The transfer switch(es) shall be prototype-tested and 3rd party certified to comply with the requirements of the IBC group III or IV, category D/F. The equipment shall be shipped with installation instructions necessary to attain installation compliance.
3. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
4. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
5. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 2 systems.
6. NEMA ICS10-1993 – AC Automatic Transfer Switches.

B. The transfer switch assembly shall comply with the following standards:
1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
2. EN55011, Class B Radiated Emissions
3. EN55011, Class B Conducted Emissions
4. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity.
5. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
6. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
7. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
8. IEC 1000-4-6 Conducted Field Immunity
9. IEC 1000-4-11 Voltage Dip Immunity.
10. IEEE 62.41, AC Voltage Surge Immunity.
11. IEEE 62.45, AC Voltage Surge.
12. UL1008 – Transfer Switches. Transfer switches and enclosures shall be UL1008 listed as a packaged, and labeled to be suitable for use in emergency, legally required, and optional standby applications.

1.3 ACCEPTABLE MANUFACTURERS:

A. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on microprocessor-based transfer switches manufactured by Cummins Power Generation.

1.4 SUBMITTALS:

A. Shop Drawings:
1. Outline drawings of assembly.
2. Internal electrical wiring and control drawings.
3. Interconnection wiring diagrams
4. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.

B. Product Data:
1. Technical data on all major components. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch.

C. Contract Closeout Information:
1. Operating and maintenance data.

1.5 QUALIFICATIONS:

A. The supplier of the transfer switch equipment shall be the supplier of the generator set.

B. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years.

1.6 REGULATORY REQUIREMENTS:

A. The transfer switch equipment shall UL1008 listed and labeled, and labeled as suitable for use in emergency, legally required, and optional standby installations.

1.7 WARRANTY:

A. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of one (2) year from registered commissioning and start-up.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc. shall be allowed during the minimum noted warranty period described in paragraph A above.

PART 2 - PRODUCTS

2.1 POWER TRANSFER SWITCH:

A. Ratings
1. Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
2. Main contacts shall be rated for 600 Volts AC minimum.
3. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet.
4. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings and at the specified voltage. The transfer switch and its upstream protection shall be coordinated. The transfer switch equipment shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

B. Construction

1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions.
2. The transfer switch operation shall include the ability to switch to an open position (both sources disconnected) for the purpose of load shedding from the generator set.
3. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1. Phase monitoring/timing equipment is not an acceptable substitute for this functionality.
4. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
5. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
6. Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
7. Transfer switches designated on the drawings as 4-pole shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.
8. Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

C. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

2.2 TRANSFER SWITCH CONTROL:

A. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

1. High intensity LED lamps to indicate the source that the load is connected to (Source 1 or Source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
2. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
3. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.

4. “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
5. “RESET/LAMP TEST” pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
6. Alphanumeric display panel with push-button navigation switches. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
    a. Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance. Line to neutral voltages shall be displayed for 4-wire systems.
    b. Display source status, to indicate source is connected or not connected.
    c. Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
    d. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
        1. Set nominal voltage and frequency for the transfer switch.
        2. Adjust voltage and frequency sensor operation set points.
        3. Enable or disable control functions in the transfer switch, including program transition.
        4. Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.

B. Internal Controls
1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
    a. Monitoring all phases of the normal service (Source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
    b. Monitoring all phases of the emergency service (Source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
    c. Monitoring all phases of the normal service (Source 1) and emergency service (Source 2) for loss of a single phase.
    d. Monitoring all phases of the normal service (Source 1) and emergency service (Source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
    e. Monitoring all phases of the normal service (Source 1) and emergency service (Source 2) for over or under frequency conditions.
    f. The controls shall monitor the operating speed of the contact mechanism, and adjust sync check parameters to result in contact closure within acceptable ranges as the equipment ages. Sync check window and time delay shall be field adjustable.

3. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).

C. Control Interface

1. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
2. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
3. The transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.

2.3 ENCLOSURE:

A. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70. The cabinet door shall include permanently mounted key type latch(es). Bolted covers or doors are not acceptable.

B. Transfer switch equipment mounted in a controlled indoor environment shall be provided in an NEMA 1/IP32 enclosure.

C. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

PART 3 - OPERATION

3.1 OPEN TRANSITION SEQUENCE OF OPERATION:

A. Transfer switch normally connects an energized utility power source (Source 1) to loads and a generator set (Source 2) to the loads when normal source fails. The normal position of the transfer switch is Source 1 (connected to the utility), and no start signal is supplied to the genset.

B. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:

1. Transfer switch shall initiate the exercise sequence when manually initiated by the operator.
2. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
3. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
4. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.

5. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

C. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:
1. Transfer switch shall initiate the exercise sequence when manually initiated by the operator.
2. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
3. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

PART 4 - OTHER REQUIREMENTS

4.1 FACTORY TESTING

A. The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. Test process shall include calibration of voltage sensors.

4.2 SERVICE AND SUPPORT:

A. The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The transfer switch shall be serviced by a local service organization that is trained and factory certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

D. After generator set installation, the generator set supplier shall conduct a complete operation, basic maintenance, and emergency service seminar for up to 10 persons employed by the facility owner. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, and emergency operation procedures.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1. GENERAL

1.1 WORK INCLUDED:

A. Furnish and install lighting fixtures, lamps, and accessories for lighting outlets in accordance with the drawings. Furnish and install a lighting fixture of the same type as indicated for areas of similar usage wherever the type designation is omitted on the drawings.

B. Furnish and install a plaster frame for each recessed fixture as required by the type of building construction. Furnish and install hangers, bolts, or other devices required to properly and adequately support each lighting fixture from the structure. Fixtures may be supported from the suspended ceiling where specific ally permitted by the construction specified in other Divisions of Work.

1.2 REFERENCE DOCUMENTS:

A. The General Electrical Provisions are hereby made a part of this Section of the Work. Refer to Section 26 00 00.

B. Each lighting fixture shall be constructed in accordance with the applicable provisions of the Electrical Code as suitable for the location where they are indicated to be installed.

C. Each lighting fixture shall bear the Underwriters' Label indicating the fixture is suitable for the application and installation location.

1.3 SUBMITTAL:

A. Submit adequately descriptive data including published catalog data or shop drawings for each type listing of lighting fixture for review prior to purchases or installation.

B. If a substitute for a fixture specified is proposed, submit, when so requested, photographs, laboratory test data and samples of both the specified and the proposed fixture to demonstrate that the proposed substitute is an acceptable equal to the specified fixture. Rejection of an offered substitute shall not be basis for work delay or extra compensation.

PART 2. PRODUCTS

2.1 LIGHTING FIXTURES:

A. Lighting fixtures shall be of the type, manufacturer, and construction as indicated in the Lighting Fixture Schedule.

B. Each fixture shall be complete with all proper components and accessories.

C. Surface mounted fluorescent fixtures shall have spacers to achieve required separation from low density ceilings construction.

2.2 LAMPS:

A. Lamps shall be energy saving and suitable for the lighting fixture installed and in accordance with the schedules and shall be manufactured by General Electric, Sylvania, or North American Phillips Corporation.

B. Fluorescent lamps shall be 3500 Kelvin, 80% or greater CRI, except as listed for color, energy savings, or special duty.

D. Other lamps shall be as specifically listed and be for the duty, lighting quality and application selected.

2.3 BALLASTS:

A. Each lighting fixture shall be equipped with a proper energy saving ballast in accordance with the operating requirements of the lighting fixture. Each ballast shall be UL listed and carry a UL label for the lighting fixture and installation specified. Ballasts shall be manufactured by Advance, GE, Jefferson, or Universal.

B. Fluorescent ballasts shall be CBM certified, high power factor type and sound rated for the lowest rating available for the application. Ballasts for lamps rated 430 ma and below shall be soundrating "A". Each ballast shall have the sound rating listed thereon. Ballasts shall be Premium Class P for those types where the requirements have been established. Other ballasts, where indicated, shall be energy saving type and shall be equal to Advance Mark III.

C. Other gaseous discharge lamp ballasts shall be high power factor constant wattage type. These ballasts for fixtures on building interior mounting shall be full enclosed in a metal housing which is filled with thermosetting sound absorbing and encapsulating material. The interior ballast shall, on recessed fixtures, be mounted separate from the reflector and socket but shall be removable without tools through the fixture ceiling opening. Each ballast shall be provided with a line disconnecting device and thermal protection.

2.4 ACCESSORIES:

A. Recessed lighting fixtures for mounting in lay-in type ceilings shall be provided with tee clamp lock-in supports when it is acceptable to support the fixtures from the tees. Recessed fixtures will have all required plaster frames, concrete inserts, gaskets, sight shields and similar accessory components required for the particular installations in this project.

B. Lighting fixtures indicated to have integral battery, charger and inverter from emergency light shall have equipment specially designed for and installed in the fixture. Units shall be with test and 90-minute illumination capability. Units for fluorescent fixtures shall be Siltron Unit-Pak.

PART 3. EXECUTION

3.1 FIXTURES:

A. Each lighting fixture shall be carefully installed in accordance with the manufacturer's directions and to fit the general construction of the walls, ceilings or other areas where the fixture is indicated. Refer to reflected ceiling plans, elevations and other details for the exact locations of fixtures. Where those details or other instructions do not indicate lighting fixture locations, position the fixtures proportionally in spaces using the arrangement indicated on the electrical drawings plus center, parallel and space the lighting fixtures and rows of fixtures on and with general construction lines.

B. Install recessed lighting fixtures in accordance with the lighting fixture manufacturer's instructions for the application. Install above ceiling junction boxes to provide ready access through the ceiling opening. Install hangers to support fixtures independent of suspended ceilings unless the ceiling is specifically designed to support the fixture. Any above-ceiling insulation materials are prohibited to be within 3" of recessed lighting fixtures.

C. Mount surface lighting fixtures to the ceiling in accordance with the lighting fixture manufacturer's instructions. Provide through-ceiling-to-structure-above supports for each lighting fixture mounted on suspended ceiling unless the ceiling is specifically designed to support the lighting fixture. Narrow channel or box-mounted lighting fixtures on tee-bar type

ceilings shall be connected through outlet boxes centered above the fixture and supported squarely on the tees. Provide auxiliary above-ceiling supports for the ceiling where tees must be cut.

D. Securely anchor bracket mounted fixtures to maintain vertical and horizontal alignment. Provide that all mounting devices are concealed.

3.2 LAMPS:

A. Each fixture shall be equipped with a set of new lamps of the size and type specified, and left in a condition such that there is a new lamp in each receptacle in each fixture upon completion and acceptance of the work. Low-energy or energy-saving type lamps shall be furnished and installed where indicated and shall specifically match the fixture, socket and ballast selection.

B. Use permanent fixtures with final lamps to allow final touch-up painting to be performed under completed building light. Permanent fixtures used for other temporary lighting shall have the lamps so used removed and not be reused for final lamping of the job. Specific approval by the Owner shall be obtained for time of installation of the final complement of lamps.

C. Replace all lamps that fail or have blackened ends during the period of touch-up, replace all lamps that have been used more that 1/4 of their rated life. This use time will be determined by the Owner's records.

3.3 TESTING, CLEANING, AIMING AND ADJUSTING:

A. Each fixture shall be placed in proper operating condition, equipped with the proper lamp and properly fitted and adjusted to aim, focus, and physically work in the spaces and construction where installed. Fixtures shall be left clean of all dust, dirt, grease and other foreign materials. Reflectors and lenses shall be clean and undamaged. Trims, finishes, and housings shall fit together and to the building construction and show no evidence of damage, handling, misalignment.

END OF SECTION

SECTION 28 31 00

FIRE DETECTION AND ALARM SYSTEM

PART 1 GENERAL

1.1 SCOPE & RELATED DOCUMENTS

A. This performance specification provides the minimum requirements for the Fire Detection and Alarm System. The system shall include, but not limited to all equipment, materials, labor, documentation and services necessary to furnish and install a complete, operational system to include but not limited to the following functions:
   1. Smoke and fire detection.
   2. Sprinkler suppression system monitoring and control.
   3. Off-premise notification.

B. The requirements of the conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.

C. The complete installation shall conform to the applicable sections of NFPA-72, Local Code Requirements and National Electrical Code Article 76

D. The work covered by this section of the specifications shall be coordinated with the related work as specified under the following:

   Section 21 13 13 – Wet-Pipe Sprinkler System
   Section 26 05 33 – Raceways and Boxes for Electrical Systems

1.2 QUALITY ASSURANCE

A. Each and all items of the Fire Detection and Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.

B. In addition to the UL-UOJZ requirement listed above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.

1.3 MANUFACTURER

A. The manufacturer of the system equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document.

B. All System components shall be the cataloged products of a single supplier. All products shall be listed by the manufacturer for their intended purpose.

C. Edwards Systems Technology, Inc. products constitute the minimum type and quality of equipment to be installed.

D. All control panel assemblies and connected field appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as to ensure that a fully functioning is designed and installed. The system supplied under this specification shall be a microprocessor-based, system. The system shall utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.

1.4 GENERAL

A. All work and materials shall conform to all applicable Federal, State and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state or local codes, and this specification, it is the bidder's responsibility to immediately bring the conflict to the attention of the Engineer for resolution. National standards shall prevail unless local codes are more stringent.

B. System components proposed in this specification shall be ULI listed to operate together as a system. The supplier shall provide evidence, with his submittal, of listings of all proposed equipment and combinations of equipment. The supplier shall be responsible for filing of all documents, paying all fees (including, but not limited to plan checking and permit) and securing all permits, inspections and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the supplier shall immediately forward two sets of drawings to the Owner. These drawings shall either be stamped approved or a copy of the letter stating approval shall be included.

1.5 CODES

A. The equipment and installation shall comply with the current provisions of the following codes and standards:

NFPA 70 - National Electric Code
NFPA 72 - National Fire Alarm Code®
NFPA 90A - Air Conditioning Systems
NFPA 101- Life Safety Code®
UL 864 - Control Units for Fire Protective Signaling Systems.
UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
UL 268A - Smoke Detectors for Duct Applications.
UL 521 - Heat Detectors for Fire Protective Signaling Systems.
UL 464 - Audible Signaling Appliances.
UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
UL 1971 - Signaling Devices for the Hearing-Impaired.
UL 1481 - Power Supplies for Fire Protective Signaling Systems.
Factory Mutual (FM) approval
Local Authority Having Jurisdiction
Federal Codes and Regulations
Americans with Disabilities Act (ADA)

1.6 SYSTEM DESCRIPTION

A. General:
1. The Contractor shall furnish all labor, services and materials necessary to furnish and install a complete, functional fire alarm system (System). The System shall comply in respects with all pertinent codes, rules, regulations and laws of the Authority, and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, manufacturer's recommendations and Underwriters Laboratories Inc. (ULI) listings.
2. It is further intended that upon completion of this work, the Owner be provided with:
a. Complete information and drawings describing and depicting the

entire system(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system(s) at a future date.

b. Complete documentation of system(s) testing.

c. Certification that the entire system(s) has/have been inspected and tested, is/are installed entirely in accordance with the applicable codes, standards, manufacturer's recommendations and ULI listings, and is/are in proper working order. Contractor shall use "Fire Alarm System Certification and Description" as required by Section 1-6.2 of NFPA 72 - 1999 edition.

B. Description 24VDC NACs: Provide and install a new fire detection and alarm system that shall consist of:

1. Fire Alarm Control Panel located as shown on the drawings.
2. LCD remote annunciator(s) located as shown on the drawings.
3. Manual pull stations located as shown on the drawings.
4. Area smoke detectors located as shown on drawings.
5. Area heat detectors located as shown on drawings.
6. Duct smoke detectors located as shown on the drawings.
7. Sprinkler system waterflow(s) and valve supervisory switch(s) located as shown on the drawings.
8. Interface with suppression system(s) as shown on the drawings.
9. Provide audible notification appliances located as shown on the drawings.
10. Provide synchronized visual notification appliances located as shown on the drawings.
11. Provide magnetic door holders, located as shown on drawings.
12. Provide elevator recall functions for primary and alternate floors and elevator power shunt trip activation.
13. Provide connection to a central station. The owner shall arrange for two dedicated phone lines to be terminated as directed by the installing contractor.

1.7 SEQUENCE OF OPERATIONS:

A. The alarm activation of any area smoke detector, heat detector, manual pull station, sprinkler waterflow, the following functions shall automatically occur:

1. The internal audible device shall sound at the control panel and remote annunciator.
2. The LCD display shall indicate all applicable information associated with the alarm condition including; device type, device location and time/date.
3. Any remote or local annunciator LCD/LED's associated with the alarm shall be illuminated.
4. Activate notification audible appliances throughout the building.
5. Activate visual strobes notification appliances throughout the building. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the "Alarm Silence" is pressed.
6. Transmit an alarm signal to the central station.
7. All stairwell/exit doors shall unlock throughout the building.
8. All self-closing fire/smoke doors held open shall be released.

B. The Alarm activation of any duct smoke detector, the following functions shall automatically occur:

1. The internal audible device shall sound at the control panel and remote annunciator.
2. The LCD display shall indicate all applicable information associated with

the alarm condition including; device type, device location and time/date.

3. Any remote or local annunciator LED's associated with the alarm shall be illuminated.
4. Transmit signals to remote annunciator(s).
5. Transmit an alarm signal to the central station.
6. Shutdown the local air handling unit.

C. Upon supervisory activation of any sprinkler valve supervisory switch, the following functions shall automatically occur:

1. The internal audible device shall sound at the control panel and remote annunciator.
2. The LCD display shall indicate all applicable information associated with the supervisory condition including; device type, device location and time/date.
3. Any remote or local annunciator LCD/LED's associated with the supervisory activation shall be illuminated.
4. Transmit a supervisory signal to the central station.

D. Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:

1. The internal audible device shall sound at the control panel and remote annunciator.
2. The LCD display shall indicate all applicable information associated with the trouble condition including; device type, device location and time/date.
3. Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.
4. Transmit a trouble signal to the central station.

E. Upon activation of any device connected to a monitor circuit, the following functions shall automatically occur:

1. The monitor LED will light and pre-programmed functions will activate.

1.8 SYSTEM CONFIGURATION

A. General:

1. All Fire Detection and Alarm System equipment shall be arranged and programmed to provide a system for the early detection of fire, the notification of building occupants, the automatic summoning of the local fire department, the override of the HVAC system operation, and the activation of other auxiliary systems to inhibit the spread of smoke and fire, and to facilitate the safe evacuation of building occupants.
2. The System shall utilize independently addressed, smoke detectors, heat detectors and input/output modules as described elsewhere in this specification.

B. Power Supply:

1. The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 4.5A continuous for notification appliance circuits. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 30 minutes. The power supply shall be an EST model 2-PPS.
2. Auxiliary power supplies shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or

brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 6.4A continuous for notification appliance circuits. The power supply shall be capable of providing 8A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 30 minutes. All supervision of the auxiliary supply shall be transmitted via addressable analog loop without additional equipment. The auxiliary power supply shall be an EST model SIGA-APS.

C. Display:
1. The display module shall be of membrane style construction with a 4 line by 20 character Liquid Crystal Display. In the normal mode display the time, the total number of active events and the total number of disable points. In the alarm mode display the total number of events and the type of event on display. The module shall have visual indicators for the following common control functions; AC Power, alarm, supervisory, monitor, trouble, disable, ground fault, CPU fail, and test. There shall be common control keys and visual indicators for; reset, alarm silence, trouble silence, drill, and one custom programmable key/indicator. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward / backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicator that lights when an event of its type is active. Allow the first event of the highest priority to capture the LCD for display so that arriving fire fighters can view the first alarm event "hands free". Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero through nine with delete and enter keys.
2. The display module shall be an EST model 2-LCD.

D. Initiating Device Circuits:
1. The Initiating device circuits (IDC) used to monitor manual fire alarm stations, smoke and heat detectors, waterflow switches, valve supervisory switches, fire pump functions, and air pressure supervisory switches shall be Class B (Style "A" or "B").
2. The Initiating device circuits shall be EST Signature series modules.

E. 24 VDC Notification Appliance Circuits:
1. 24 VDC Notification appliance circuits (NAC) shall be Class B (Style "Y"). All notification appliance circuits shall have a minimum circuit output rating of 2 amp @ 24 vdc. The notification circuits shall be power limited. Non-power limited circuits are not acceptable.
2. The 24 VDC Notification appliance circuits shall be EST Signature series modules.

F. Signaling Line Circuits:
1. The signaling line circuit shall communicate from a panel/node to analog/addressable detectors, input modules, output modules, isolation modules and notification appliance circuits.
2. Each signaling circuit connected to addressable/analog devices shall provide a minimum of 20 spare addresses.
3. When a signaling line circuit covers more than one fire/smoke compartments, a wire-to-wire short shall not effect the operation of the circuit from the other fire/smoke compartments.
4. The signaling line circuit (SLC) connecting panels and annunciators shall

be Class B (style 4).

5. The signaling line circuit connecting to addressable/analog devices including, detectors, monitor modules, control modules, isolation modules, and notification circuit modules shall be Class B (style 4).

G. Dialer:

1. The panel shall have a dialer (alarm communicator transmitter (DACT)) module to transmit alarm, supervisory and trouble signals to a Central Monitoring Station (CMS). It shall be possible to delay AC power failure reports, auto test call, and site program using a touch tone phone and password.
2. The dialer shall be an EST model DL2.

1.9 SUBMITTALS

A. Project Submittal:

1. The contractor shall purchase no equipment for the system specified herein until the owner has approved the project submittals in their entirety and has returned them to the contractor. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications.
2. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the contract documents. In addition the contractor shall provide specific notation on each shop drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.
3. All drawings and diagrams shall include the Contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewers initials.

B. Product Data:

1. Data sheets with the printed logo or trademark of the manufacturer for all equipment. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of the Architect/Engineer.

C. Shop Drawings: A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:

1. Control panel wiring and interconnection schematics.
2. Complete point to point wiring diagrams.
3. Complete floor plan drawing locating all system devices and 1/4' = 1'-0 scale plan and elevation of all equipment in the Fire Command Station. Including showing the placement of each individual item of fire alarm equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.
4. Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.
5. Complete system bill of material.
6. Complete calculations shall be provided which show the electrical load on the following system components:
   a. Each system power supply, including stand alone booster

supplies.
b. Each standby power supply (batteries).
c. Each notification appliance circuit.
d. Each auxiliary control circuit that draws power from any system power supply.

D. Closeout Submittal: (2) copies of the following documents shall be delivered to the building owner's representative at the time of system acceptance. The close out submittals shall include:
1. Project specific operating manuals covering the installed Fire Detection and Alarm System. A generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.
2. As-Built drawings consisting of: a scaled plan of each building showing the placement of each individual item of the Fire Detection and Alarm System equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway. All drawings must reflect point to point wiring, device address and programmed characteristics unless device addressing is electronically generated, and automatically graphically documented by the system.
3. Provide all drawings shall be provided in standard .DWG format.
4. Provide the name, address and telephone of the authorized factory representative.
5. A filled out Record of Completion similar to NFPA 72, 1999 edition figure 1-6.2.1.

1.10 WARRANTY AND MAINTENANCE

A. The contractor shall warranty all materials, installation and workmanship for one (1) year from date of acceptance, unless otherwise specified. A copy of the manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.

B. The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor.

1.11 SPARE PARTS

A. The Contractor shall supply the following spare parts:
1. Automatic detection devices - Two (2) percent of the installed quantity of each type.
2. Manual fire alarm stations - Two (2) percent of the installed quantity of each type.
3. Audible and visible devices - One (1) percent of the installed quantity of each type, but no less than two (2) devices.
4. Keys - A minimum of three (3) sets of keys shall be provided and appropriately identified.

1.12 TRAINING

A. The System Supplier shall schedule and present a minimum of 2 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.

B. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and

who is also thoroughly familiar with the installation.

C. The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

D. Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable fire alarm system manufacturers include:
1. Edwards Systems Technology, Inc.

B. All equipment and components shall be the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

C. The contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer.

2.2 PANEL COMPONENTS & FUNCTIONS

A. General
1. The control panel shall be a multi-processor-based system designed specifically for fire and releasing system applications. The control panel shall be listed and approved for the application standard(s) as listed under the General section.
2. The control panel shall include all required hardware, software and system programming to provide a complete and operational system.
3. Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display. Software and processor operation shall be independently monitored for failure.

B. Annunciation
1. The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building. Manufacturer's standard control switches shall be acceptable if they provide the required operation, including performance, supervision and position indication.
2. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device.
3. The networked annunciator(s) shall be an EST EST2 series.

C. Power Supply
1. Each system power supply shall be a minimum of 6 amps @ 24 vdc.
2. Upon failure of normal (AC) power, the affected portion(s) of the system

shall automatically switch over to secondary power without losing any alarm, trouble or operator acknowledgment signals.

3. Each system power supply shall be individually annunicated and shall identify the inoperable power supply in the event of a trouble condition.
4. All standby batteries shall be continuously monitored by the system. Low battery and disconnection of battery power supply conditions shall immediately annunciate as a trouble signal, identifying the deficient batteries.
5. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.
6. The power supply shall be an EST model 2-PPS/6A.

D. Display

1. The system shall allow message routing to be configured to any or all annunciators.
2. Each LCD display on each annunciator shall be configurable to display the status of any combination of alarm, supervisory, trouble, or monitor, event messages.
3. Clear distinction shall be provided between alarm, supervisory, trouble, and monitor status messages.
4. A standby power supply shall automatically supply electrical energy to the system upon primary power supply failure.

E. Dialer

1. The system shall provide an off premise Digital Alarm Communications Transmitter (DACT) capable of transmitting system alarm, trouble and supervisory events to a central monitoring station (CMS). The DACT shall support dual telephone lines, 20 PPS 4/2 communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and site program the DACT using a touch tone phone and password.
2. The DACT shall be an EST model DL2.

2.3 INITIATING DEVICES

A. Analog Addressable Smoke General

1. Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive or least sensitive.
2. The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal that 80% to 99% compensation has been used. The detector shall provide a dirty fault signal that 100% compensation has been used.
3. The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

B. Smoke Detectors

1. The system shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. Each smoke detector shall be capable of transmitting alarm signals as well as normal, trouble and need cleaning information. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value.
2. The analog/addressable photoelectric smoke detector shall be an EST model SIGA-PS.
3. The analog/addressable ionization smoke detector shall be an EST model SIGA-IS.

C. Fixed Temperature Heat Detector
1. The heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C). The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.
2. The analog/addressable fixed temperature heat detector shall be EST model SIGA-HFS.

D. Fixed Temperature-Rate of Rise Heat Detector
1. The heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate of rise alarm point of 15°F(9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.
2. The analog/addressable combination fixed temperature / rate-of-rise detector shall be EST model SIGA-HRS.

E. Manual Station - Single Action Single Stage
1. Provide analog/addressable single action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of metal construction and incorporate an internal toggle switch. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering.
2. The analog/addressable single action, single stage fire alarm stations shall be EST model SIGA-270.

F. Manual Station - Double Action Single Stage
1. Provide analog/addressable double action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering.
2. The analog/addressable double action, single stage fire alarm station shall be EST model SIGA-278.

2.4 NOTIFICATION APPLIANCES

A. General
1. All appliances which are supplied for the requirements of this specification shall be UL Listed for Fire Protective Service, and shall be capable of providing the "equivalent facilitation" which is allowed under the Americans with Disabilities Act Accessabilities Guidelines

(ADA(AG)), and shall be UL 1971 Listed.

2. All appliances shall be of the same manufacturer as the fire alarm control panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturer's instructions.

B. Vibrating Bells

1. Vibrating fire alarm bells shall be the under dome type, utilize a heavy-duty mechanism, and be polarized for supervised operation. Use 6" 83 dBA, 8" 84 dBA and/or 10" 86dBA diameter gongs as required. Provide weatherproof wall boxes for outdoor mounting. Provide flush wall mounted enclosures as required. Enclosure grills shall be finished with prime coat or stainless steel as required.
2. The vibrating bell shall be EST model 439D-<6><8><10>AW-R.

C. Vibrating Bell-Strobe

1. Vibrating bell/strobes shall provide synchronized flash. Strobe output shall be determined as required by its specific location and application from a family of 15cd, 75cd, &110cd devices.
2. The vibrating bell/strobe shall be EST model 439D-<6><8><10>AW-R bell on a 403-xA-R strobe adapter plate.

D. Low Profile Horns

1. Low profile wall mount horns shall provide an 84 dBA sound output at 10 ft. when measured in reverberation room per UL-464. The horn shall have a selectable steady or synchronized temporal output.
2. The low profile wall mount horns shall be EST Genesis series.

E. Heavy Duty Horns

1. Heavy duty electronic horns shall be selectable for high or low dBA output and steady or temporal output. At the high output setting, the horn shall provide a 85 dBA continuous sound output or a 82 dBA temporal sound output, when measured in reverberation room per UL-464. Weatherproof wall boxes shall be provided for outdoor applications.
2. The heavy duty electronic horns shall be EST Integrity series.

F. Low Profile Horn-Strobes

1. Low profile wall mount horn/strobes shall provide an audible output of 84 dBA at 10 ft. when measured in reverberation room per UL-464. Strobes shall provide synchronized flash outputs. The strobe output shall be determined as required by its specific location and application from a family of 15cd, 30cd, 60cd, 75cd & 110cd devices. The horn shall have a selectable steady or synchronized temporal output.
2. The low profile wall mount horn/strobes shall be EST Genesis series.

G. Heavy Duty Horn-Strobes

1. Heavy duty horn/strobes shall be selectable for high or low dBA output and steady or temporal output. At the high output setting, the horn shall provide a 85 dBA continuous sound output or a 82 dBA temporal sound output, when measured in reverberation room per UL-464. Strobes shall provide synchronized flash outputs. The strobe output shall be determined as required by its specific location and application using 15/75cd or 110cd devices. Weatherproof wall boxes shall be provided for outdoor applications.
2. The heavy duty horn/strobes shall be EST Integrity series.

H. Low Profile Strobes

1. Low profile wall mounted strobes shall provide synchronized flash outputs. Strobe output shall be determined as required by its specific location and application from a family of 15cd, 30cd, 60cd, 75cd, or 110cd devices.
2. The low profile wall mounted strobes shall be EST Genesis series.

I. Heavy Duty Strobes

1. Heavy duty strobes shall provide synchronized flash. Strobe output shall be determined as required by its specific location and application using 15/75cd or 110cd devices. For outdoor application provide weatherproof wall boxes for mounting.
2. The heavy duty strobes shall be EST Integrity series.

2.5 INITIATION & CONTROL MODULES

A. General

1. It shall be possible to address each intelligent module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. The module shall be capable of storing up to 24 diagnostic codes which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:

   Temperature: 32oF to 120oF (0oC to 49oC)
   Humidity: 0-93% RH, non-condensing

B. Control Relay Module

1. Intelligent control relay modules shall provide one form "C" dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.
2. The addressable control relay circuit module shall be an EST model SIGA-CR.

C. Dual Input Module

1. Intelligent dual input modules shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The dual input module shall support the following circuit types:
   a. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
   b. Normally-Open Alarm Delayed Latching (Waterflow Switches)
   c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
   d. Normally-Open Active Latching (Supervisory, Tamper Switches
2. The intelligent dual input module shall be an EST model SIGA-CT2.

D. Dual Input Signal Module

1. Intelligent dual input signal modules shall provide a means to selectively connect one of two (2) signaling circuit power risers to one (1) supervised output circuit. The dual input signal module shall support the following operation:

a. Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25 Vrms @ 50w or 70 Vrms @ 35w of Audio).

2. The intelligent dual input signal module shall be an EST model SIGA-CC2.

E. Single Input Module

1. Intelligent single input modules shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The single input module shall support the following circuit types:
   a. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
   b. Normally-Open Alarm Delayed Latching (Waterflow Switches)
   c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
   d. Normally-Open Active Latching (Supervisory, Tamper Switches)
2. The intelligent single input module shall be an EST model SIGA-CT1.

F. Single Input Signal Module

1. Intelligent single input signal modules shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The single input signal module shall support the following operations:
   a. Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)
   b. Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)
2. The intelligent single input signal module shall be an EST model SIGA-CC1.

G. Universal Class AB Module

1. Intelligent class A/B modules shall be capable of a minimum of fifteen (15) distinct operations. The universal class A/B module shall support the following circuit types:
   a. Two (2) supervised Class B Normally-Open Alarm Latching.
   b. Two (2) supervised Class B Normally-Open Alarm Delayed Latching.
   c. Two (2) supervised Class B Normally-Open Active Non-Latching.
   d. Two (2) supervised Class B Normally-Open Active Latching.
   e. One (1) form "C" dry relay contact rated at 2 amps @ 24 Vdc.
   f. One (1) supervised Class A Normally-Open Alarm Latching.
   g. One (1) supervised Class A Normally-Open Alarm Delayed Latching.
   h. One (1) supervised Class A Normally-Open Active Non-Latching.
   i. One (1) supervised Class A Normally-Open Active Latching.
   j. One (1) supervised Class A 2-wire Smoke Alarm Non-Verified.
   k. One (1) supervised Class B 2-wire Smoke Alarm Non-Verified.
   l. One (1) supervised Class A 2-wire Smoke Alarm Verified
   m. One (1) supervised Class B 2-wire Smoke Alarm Verified
   n. One (1) supervised Class A Signal Circuit, 24Vdc @ 2A.
   o. One (1) supervised Class B Signal Circuit, 24Vdc @ 2A.
2. The intelligent class A/B module shall be an EST model SIGA-UM.

H. Waterflow-Tamper Module

1. Intelligent waterflow/tamper modules shall be factory set to support two (2) supervised Class B input circuits. Channel A shall support a

Normally-Open Alarm Delayed Latching Waterflow Switch circuit. Channel B shall support a Normally-Open Active Latching Tamper Switch.

2. The intelligent waterflow/tamper module shall be an EST model SIGA-WTM.

2.6 GRAPHIC ANNUNCIATORS

A> The annunciator graphical diagram shall be a scaled representation and operate on nominal 24 Vdc. All annunciator switches shall be system input points and shall be capable of controlling any system output or function. The graphic annunciator shall be UL and ULC Listed. The graphic shall be back-lit using high intensity LEDs. The unit shall be semi-flush mounted. The main graphic door shall be tamper resistant and equipped with a key lock. It shall be possible to update the graphic image in the field without replacing the entire graphic.

B. The graphic annunciator shall be an EST Envoy series.

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. All equipment shall be attached to walls and ceiling/floor assemblies and shall be mounted firmly in place. Detectors shall not be supported solely by suspended ceilings. Fasteners and supports shall be sized to support the required load.

B. Conductors

1. The requirement of this section apply to all system conductors, including all signaling line, initiating device, notification appliance, auxiliary function, remote signaling, AC and DC power and grounding/shield drain circuits, and any other wiring installed by the Contractor pursuant to the requirements of these Specifications.
2. All circuits shall be rated power limited in accordance with NEC Article 760.
3. All new system conductors shall be of the type(s) specified herein.
   a. All initiating circuit, signaling line circuit, AC power conductors, shield drain conductors and grounding conductors, shall be solid copper, stranded or bunch tinned (bonded) stranded copper.
   b. All signaling line circuits, including all addressable initiating device circuits shall be 18 AWG minimum multi-conductor jacketed twisted cable or twisted shielded or as per manufacturer's requirements.
   c. All non-addressable initiating device circuits, 24 VDC auxiliary function circuits shall be 18 AWG minimum or per manufacturer's requirements.
   d. All notification appliance circuit conductors shall be solid copper or bunch tinned (bonded) stranded copper. Where stranded conductors are utilized, a maximum of 7 strands shall be permitted for No. 16 and No. 18 conductors, and a maximum of 19 strands shall be permitted for No. 14 and larger conductors.
   e. All audible notification appliance circuits shall be 14 AWG minimum twisted pairs or twisted pairs shielded or per manufacturer's requirements.
   f. All visual notification appliance circuits shall be 14 AWG minimum THHN or twisted pairs or twisted shielded pairs or per

manufacturer's requirements.

C. Conductors and Raceway
1. Except as otherwise required by Code and/or these Specifications, the installation of all system circuits shall conform to the requirements of Article 760 and raceway installation to the applicable sections of Chapter 3 of NFPA 70, National Electrical Code. Fire alarm circuit wiring shall include all circuits described in Section 760-1 including Fine Print Note No. 1 (FPN No. 1), and as defined by the manufacturer's UL listing.
2. The entire system shall be installed in a skillful manner in accordance with approved manufacturer's installation manuals, shop drawings and wiring diagrams. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type required by the NEC and approved by local authorities having jurisdiction for the purpose.
3. Any shorts, opens, or grounds found on new or existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.
4. The contractor shall neatly tie-wrap all field-wiring conductors in the gutter spaces of the control panels and secure the wiring away from all circuit boards and control equipment components. All field-wiring circuits shall be neatly and legibly labeled in the control panel. No wiring except home runs from life safety system circuits and system power supply circuits shall be permitted in the control panel enclosures. No wiring splices shall be permitted in a control panel enclosure.
5. All penetration of floor slabs and firewalls shall be fire stopped in accordance with all local fire codes.

D. Open Cable
1. Power-limited cable in accordance with NEC 70, where used, not installed in UL listed metal conduit or raceway shall be mechanically protected by building construction features:
2. Installation shall be in areas not subjected to mechanical injury.
3. All circuits shall be supported by the building structure. Cable shall be attached by straps to the building structure at intervals not greater than 10 feet. Wiring installed above drop ceilings, cable shall not be laid on ceiling tiles. Cable shall not be fastened in a manner that puts tension on the cable.
4. Cable type shall be FPLP, FPLR or FPL, or permitted substitutions, selected for the installation application as required by NEC 70, Section 760-61.
5. All cable that is not enclosed by conduit shall be supported and anchored with nylon straps or clamps. The use of staples is prohibited.

E. Conduit Raceway
1. All systems and system components listed to UL864 Control Units for Fire Protective Signaling Systems maybe installed within a common conduit raceway system, in accordance with the manufacture's recommendations. System(s)or system components not listed to the UL864 standard shall utilize a separate conduit raceway system for each of the sub-systems.
2. The requirements of this section apply to all system conduits, raceways, electrical enclosures, junction boxes, pull boxes and device back boxes.
3. All system conduits shall be of the sizes and types specified.
4. All system conduits shall be EMT, 3/4 -inch minimum, except for flexible metallic conduit used for whips to devices only, maximum length 6 feet, 3/4-inch diameter, minimum.

5. All system conduits, which are installed in areas, which may be subject to physical damage or weather, shall be IMC or rigid steel, 3/4 -inch minimum.
6. Conduits shall be sized according to the conductors contained therein. Cross sectional area percentage fill for system conduits shall not exceed 40%.
7. Provide all new conduit raceway and conduit riser.
8. All fire alarm conduit systems shall be routed and installed to minimize the potential for physical, mechanical or by fire damage, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance.
9. All conduits, except flexible conduit whips to devices, shall be solidly attached to building structural members, ceiling slabs or permanent walls. Conduits shall not be attached to existing conduit, duct work, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, notification, or auxiliary function devices.
10. All system conduits, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device back boxes shall be readily accessible for inspection, testing, service and maintenance.

3.2 FIELD QUALITY CONTROL

A. Test & Inspection
1. All intelligent analog addressable devices shall be tested for current address, sensitivity, and user defined message.
2. All wiring shall be tested for continuity, shorts, and grounds before the system is activated.
3. All test equipment, instruments, tools and labor required to conduct the tests shall be made available by the installing contractor.
4. The system including all its sequence of operations shall be demonstrated to the Owner, his representative, and the local fire inspector. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives and the fire inspector.
5. At the final test and inspection, a factory trained representative of the system manufacturer shall demonstrate that the system functions properly in accordance with these specifications. The representative shall provide technical supervision, and participate during all of the testing for the system.
6. All fire alarm testing shall be in accordance with National Fire Alarm Code, NFPA 72, Chapter 7.
7. A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and within the limitations of the required listings and approvals, that all system hardware and software has been visually inspected and functionally tested by a manufacturer's certified representative, and that the system is in proper working order.

END OF SECTION