

PROJECT MANUAL
TECHNICAL SPECIFICATIONS
for
BOWIE CAMPUS
HOUSTON GATEWAY ACADEMY

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HOUSTON, TEXAS 77012



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SECTION 01100**SUMMARY****PART 1 GENERAL****1.01 PROJECT**

- A. Project Name: Bowie Campus.
- B. Owner's Name: Houton Gateway Academy.
- C. Architect's Name: Architect.
- D. The Project consists of the construction of a 67,537 sq ft school.

1.02 CONTRACT DESCRIPTION

- A. Contract Type: Multiple prime contracts each based on a Stipulated Price as described in the Agreement between the Owner and Contractor.

1.03 WORK BY OWNER

- A. Existing Building Demolition: Owner has contracted for demolition of the existing structure on site and removal of its foundations. The site will be backfilled at the removed foundations and filled to existing grade elevation..
- B. Items noted NIC (Not in Contract) will be supplied and installed by Owner before Substantial Completion. Some items include:
 - 1. Movable cabinets.
 - 2. Furnishings.
 - 3. Small equipment.
 - 4. Artwork.
- C. Owner will supply and install the following:
 - 1. Kitchen equipment.
 - 2. Playground equipment.
- D. Owner will supply the following for installation by Contractor:
 - 1. Laboratory millwork.

1.04 OWNER OCCUPANCY

- A. Owner intends to occupy the Project upon Substantial Completion.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.05 CONTRACTOR USE OF SITE AND PREMISES

- A. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.

END OF SECTION

SECTION 01300**ADMINISTRATIVE REQUIREMENTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Preconstruction meeting.
- B. Site mobilization meeting.
- C. Progress meetings.
- D. Construction progress schedule.
- E. Progress photographs.
- F. Coordination drawings.
- G. Submittals for review, information, and project closeout.
- H. Number of copies of submittals.
- I. Submittal procedures.

1.02 RELATED REQUIREMENTS**1.03 PROJECT COORDINATION**

- A. Project Coordinator: Construction Manager.
- B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for _____ access, traffic, and parking facilities.
- C. During construction, coordinate use of site and facilities through the Project Coordinator.
- D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities.
- F. Coordinate field engineering and layout work under instructions of the Project Coordinator.
- G. Make the following types of submittals to Architect through the Project Coordinator:
 - 1. Requests for interpretation.
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Test and inspection reports.
 - 5. Manufacturer's instructions and field reports.
 - 6. Applications for payment and change order requests.
 - 7. Progress schedules.
 - 8. Coordination drawings.
 - 9. Closeout submittals.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 PRECONSTRUCTION MEETING**

- A. Attendance Required:
 - 1. Owner.
 - 2. Architect.

3. Contractor.
- B. Agenda:
1. Execution of Owner-Contractor Agreement.
 2. Submission of executed bonds and insurance certificates.
 3. Distribution of Contract Documents.
 4. Submission of list of Subcontractors, list of Products, schedule of values, and progress schedule.
 5. Designation of personnel representing the parties to Contract, _____, and Architect.
 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Scheduling.
- C. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.02 SITE MOBILIZATION MEETING

- A. Attendance Required:
1. Contractor.
 2. Owner.
 3. Architect.
 4. Contractor's Superintendent.
 5. Major Subcontractors.
- B. Agenda:
1. Use of premises by Owner and Contractor.
 2. Owner's requirements and occupancy prior to completion.
 3. Construction facilities and controls provided by Owner.
 4. Temporary utilities provided by Owner.
 5. Survey and building layout.
 6. Security and housekeeping procedures.
 7. Schedules.
 8. Application for payment procedures.
 9. Procedures for testing.
 10. Procedures for maintaining record documents.
 11. Requirements for start-up of equipment.
 12. Inspection and acceptance of equipment put into service during construction period.
- C. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Attendance Required: Job superintendent, major Subcontractors and suppliers, Owner, Architect, as appropriate to agenda topics for each meeting.
- C. Agenda:
1. Review minutes of previous meetings.
 2. Review of Work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems that impede, or will impede, planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Maintenance of progress schedule.
 7. Corrective measures to regain projected schedules.
 8. Planned progress during succeeding work period.
 9. Maintenance of quality and work standards.
 10. Effect of proposed changes on progress schedule and coordination.
 11. Other business relating to Work.

- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 CONSTRUCTION PROGRESS SCHEDULE

- A. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- B. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
 - 1. Include written certification that major contractors have reviewed and accepted proposed schedule.
- C. Within 10 days after joint review, submit complete schedule.
- D. Submit updated schedule with each Application for Payment.

3.05 PROGRESS PHOTOGRAPHS

3.06 COORDINATION DRAWINGS

3.07 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 - 1. Product data.
 - 2. Shop drawings.
 - 3. Samples for selection.
 - 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
- C. Samples will be reviewed only for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01780 - CLOSEOUT SUBMITTALS.

3.08 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 - 1. Design data.
 - 2. Certificates.
 - 3. Test reports.
 - 4. Inspection reports.
 - 5. Manufacturer's instructions.
 - 6. Manufacturer's field reports.
 - 7. Other types indicated.
- B. Submit for Architect's knowledge as contract administrator or for Owner. No action will be taken.

3.09 SUBMITTALS FOR PROJECT CLOSEOUT

- A. When the following are specified in individual sections, submit them at project closeout:
 - 1. Project record documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Other types as indicated.
- B. Submit for Owner's benefit during and after project completion.

3.10 NUMBER OF COPIES OF SUBMITTALS

- A. Documents for Review:
 - 1. Small Size Sheets, Not Larger Than 8-1/2 x 11 inches: Submit the number of copies that Contractor requires, plus two copies that will be retained by Architect.

- B. Documents for Information: Submit two copies.
- C. Documents for Project Closeout: Make one reproduction of submittal originally reviewed. Submit one extra of submittals for information.
- D. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
 - 1. After review, produce duplicates.
 - 2. Retained samples will not be returned to Contractor unless specifically so stated.

3.11 SUBMITTAL PROCEDURES

- A. Transmit each submittal with AIA Form G810.
- B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.
- C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.
- D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite the Project, and coordinate submission of related items.
- F. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
- G. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
- H. Provide space for Contractor and Architect review stamps.
- I. When revised for resubmission, identify all changes made since previous submission.
- J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- K. Submittals not requested will not be recognized or processed.

END OF SECTION

SECTION 01325**CONSTRUCTION PROGRESS SCHEDULE****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Preliminary schedule.
- B. Construction progress schedule, bar chart type.

1.02 REFERENCES

- A. AGC (CPSM) - Construction Planning and Scheduling Manual; Associated General Contractors of America; 2004.
- B. M-H (CPM) - CPM in Construction Management - Project Management with CPM, O'Brien, McGraw-Hill Book Company; 2006.

1.03 SUBMITTALS

- A. Within 10 days after date of Agreement, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Submit updated schedule with each Application for Payment.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 PRELIMINARY SCHEDULE**

- A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Identify each item by specification section number.
- C. Identify work of separate stages and other logically grouped activities.
- D. Provide sub-schedules to define critical portions of the entire schedule.
- E. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
- F. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

- A. Include a separate bar for each major portion of Work or operation.
- B. Identify the first work day of each week.

3.04 UPDATING SCHEDULE

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
- C. Annotate diagrams to graphically depict current status of Work.

- D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- E. Indicate changes required to maintain Date of Substantial Completion.
- F. Submit reports required to support recommended changes.

3.05 DISTRIBUTION OF SCHEDULE

- A. Distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Architect, Owner, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

END OF SECTION

SECTION 01400**QUALITY REQUIREMENTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Mock-ups.
- B. Control of installation.
- C. Tolerances.
- D. Testing and inspection services.

1.02 SUBMITTALS

- A. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test/inspection.
 - h. Date of test/inspection.
 - i. Results of test/inspection.
 - j. Conformance with Contract Documents.
 - k. When requested by Architect, provide interpretation of results.
- B. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
 - 1. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- D. Erection Drawings: Submit drawings for Architect's benefit as contract administrator or for Owner.
 - 1. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.03 TESTING AND INSPECTION AGENCIES

- A. Contractor shall employ and pay for services of an independent testing agency to perform specified testing and inspection.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- C. Contractor Employed Agency:
 - 1. Testing agency: Comply with requirements of ASTM E 329, ASTM E 543, ASTM C 1021, ASTM C 1077, and ASTM C 1093.
 - 2. Inspection agency: Comply with requirements of ASTM D3740 and ASTM E329.
 - 3. Laboratory: Authorized to operate in the State in which the Project is located.
 - 4. Laboratory Staff: Maintain a full time registered Engineer on staff to review services.

5. Testing Equipment: Calibrated at reasonable intervals either by NIST or using an NIST established Measurement Assurance Program, under a laboratory measurement quality assurance program.

PART 3 EXECUTION

2.01 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have Work performed by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

2.02 MOCK-UPS

- A. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be a comparison standard for the remaining Work.
- D. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, remove mock-up and clear area when directed to do so.

2.03 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

2.04 TESTING AND INSPECTION

- A. Testing Agency Duties:
 1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 2. Perform specified sampling and testing of products in accordance with specified standards.
 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
 5. Perform additional tests and inspections required by Architect.
 6. Submit reports of all tests/inspections specified.
- B. Limits on Testing/Inspection Agency Authority:
 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency may not approve or accept any portion of the Work.

3. Agency may not assume any duties of Contractor.
 4. Agency has no authority to stop the Work.
- C. Contractor Responsibilities:
1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- D. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
- E. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

2.05 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not conforming to specified requirements.
- B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01500**TEMPORARY FACILITIES AND CONTROLS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Temporary utilities.
- B. Temporary telecommunications services.
- C. Temporary sanitary facilities.
- D. Temporary Controls: Barriers, enclosures, and fencing.
- E. Security requirements.
- F. Vehicular access and parking.
- G. Waste removal facilities and services.
- H. Project identification sign.
- I. Field offices.

1.02 TEMPORARY UTILITIES

- A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.
- B. Use trigger-operated nozzles for water hoses, to avoid waste of water.

1.03 TELECOMMUNICATIONS SERVICES

- A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.
- B. Telecommunications services shall include:

1.04 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. Maintain daily in clean and sanitary condition.

1.05 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.06 FENCING

- A. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.07 SECURITY

- A. Provide security and facilities to protect Work, and Owner's operations from unauthorized entry, vandalism, or theft.

1.08 VEHICULAR ACCESS AND PARKING

- A. Coordinate access and haul routes with governing authorities and Owner.

- B. Provide and maintain access to fire hydrants, free of obstructions.
- C. Provide means of removing mud from vehicle wheels before entering streets.
- D. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

1.09 WASTE REMOVAL

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- B. Provide containers with lids. Remove trash from site periodically.
- C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.10 PROJECT IDENTIFICATION

- A. Provide project identification sign of design and construction indicated on Drawings.
- B. Erect on site at location established by Architect.
- C. No other signs are allowed without Owner permission except those required by law.

1.11 FIELD OFFICES

- A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack and drawing display table.
- B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
- C. Locate offices a minimum distance of 30 feet from existing and new structures.

1.12 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.
- B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION - NOT USED**

END OF SECTION

SECTION 01600**PRODUCT REQUIREMENTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. General product requirements.
- B. LEED-related product requirements.
- C. Transportation, handling, storage and protection.
- D. Product option requirements.
- E. Substitution limitations and procedures.
- F. Procedures for Owner-supplied products.
- G. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

- A. Section 01100 - Summary: Lists of products to be removed from existing building.
- B. Section 01355 - LEED Certification Procedures: Requirements for LEED reports.
- C. Section 01400 - Quality Requirements: Product quality monitoring.
- D. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.
- E. Section 01732 - Waste Management: Waste disposal requirements potentially affecting packaging and substitutions.

1.03 SUBMITTALS

- A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.
- D. LEED Submittals: Use forms provided in Section 01356.

PART 2 PRODUCTS**2.01 NEW PRODUCTS**

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. Do not use products having any of the following characteristics:
 - 1. Made using or containing CFC's or HCFC's.
 - 2. Made of wood from newly cut old growth timber.
- C. Where all other criteria are met, Contractor shall give preference to products that:
 - 1. Are extracted, harvested, and/or manufactured closer to the location of the project.
 - 2. Have longer documented life span under normal use.

3. Result in less construction waste.
 4. Are made of vegetable materials that are rapidly renewable.
- D. Regionally-Sourced Products:
1. Overall Project Requirement: Provide materials amounting to a minimum of 10 percent of the total value of all materials (excluding plumbing, HVAC, electrical, elevators, and other equipment) that have been extracted, harvested, or recovered, as well as manufactured, within a radius of 500 miles from the project site.
 - a. This provision is applicable to LEED Credit MR 5.1; show quantity on LEED report.
 2. Specific Product Categories: Provide regionally-sourced products as specified elsewhere.
 3. LEED Submittals: Indicate location of manufacture; in all cases indicate location of final assembly; for harvested products, indicate location of harvest; for extracted (i.e. mined) products, indicate location of extraction; for products involving multiple manufacturing steps, indicate all locations of manufacture or assembly; provide manufacturer or supplier certification of location information.
- E. Products with Rapidly Renewable Material Content:
1. Definition: Materials made from plants that are typically harvested within 10 years or less after planting.
 2. Specific Product Categories: Provide renewable material content as specified elsewhere.
 3. Calculations: Where information about renewable material content is required to be submitted and an item is not made completely of rapidly renewable material, calculate content by dividing the renewable material content by weight by the total weight of the item.
 4. LEED Submittals: State unit cost, renewable material content percentage, quantity installed, total material cost, and total renewable material value; attach evidence of contents from either manufacturer or an independent agency.
- F. Products with Recycled Content:
1. Overall Project Requirement: Provide products with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial recycled content constitutes at least 5 percent of the total value of all products installed, except mechanical and electrical components.
 - a. This provision is applicable to LEED Credit MR 4; show quantity and calculations on LEED report.
 2. Specific Product Categories: Provide recycled content as specified elsewhere.
 3. Calculations: Where information about recycled content is required to be submitted:
 - a. Determine percentage of post-consumer and post-industrial content separately, using the guidelines contained in 16 CFR 260.7(e).
 - b. Previously used, reused, refurbished, and salvaged products are not considered recycled.
 - c. Wood fabricated from timber abandoned in transit to original mill is considered reused, not recycled.
 - d. Determine percentage of recycled content of any item by dividing the weight of recycled content in the item by the total weight of all material in the item.
 - e. Determine value of recycled content of each item separately, by multiplying the content percentage by the value of the item.
 4. LEED Submittals: State unit cost, post-consumer and post-industrial content percentages, quantity installed, total material cost, and total recycled content value; attach evidence of contents from either manufacturer or an independent agency.
- G. Sustainably Harvested Wood:
1. Definition: Wood-based materials include but are not limited to structural framing, dimension lumber, flooring, wood doors, finishes, and furnishings that are permanently installed in the project. Wood and wood-based products not permanently installed in the project are not included in the definition.
 2. Overall Project Requirement: Provide a minimum of 50 percent of all wood-based materials made of sustainably harvested wood.

- a. This provision is applicable to LEED Credit MR 6/7; show quantity on LEED report and submit certificates.
3. Specific Wood-Based Fabrications: Fabricate of sustainably harvested wood when so specified elsewhere.
4. Certification: Provide wood certified or labeled by an organization accredited by one of the following:
 - a. The Forest Stewardship Council, The Principles for Natural Forest Management; for Canada visit <http://www.fsccanada.org>, for the USA visit <http://www.fscus.org>.
5. LEED Submittals: State unit cost of each wood-based item, quantity installed, quantity certified as sustainably harvested, total wood-based material cost, and total sustainably harvested value; provide letter of certification signed by supplier of each item, indicating compliance with the specified requirements and identifying the certifying organization.
 - a. Include the certifying organization's certification numbers for each certified product, itemized on a line-item basis.
 - b. Attach copies of invoices bearing the certifying organization's certification numbers.

2.02 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify time restrictions for submitting requests for substitutions during the bidding period. Comply with requirements specified in this section.
- B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- C. A request for substitution constitutes a representation that the submitter:
 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 2. Will provide the same warranty for the substitution as for the specified product.
 3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
 4. Waives claims for additional costs or time extension that may subsequently become apparent.
 5. Will reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
- D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- E. Substitution Submittal Procedure:
 1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.

2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
3. The Architect will notify Contractor in writing of decision to accept or reject request.

3.02 OWNER-SUPPLIED PRODUCTS

- A. Owner's Responsibilities:
 1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
 2. Arrange and pay for product delivery to site.
 3. On delivery, inspect products jointly with Contractor.
 4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
 1. Review Owner reviewed shop drawings, product data, and samples.
 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 3. Handle, store, install and finish products.
 4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

- A. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- B. Transport and handle products in accordance with manufacturer's instructions.
- C. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- D. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- E. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
- F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Prevent contact with material that may cause corrosion, discoloration, or staining.
- H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION

SECTION 01616**VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. VOC restrictions for product categories listed below under "DEFINITIONS."
- B. All products of each category that are installed in the project must comply; Owner's project goals do not allow for partial compliance.

1.02 DEFINITIONS

- A. VOC-Restricted Products: All products of each of the following categories when installed or applied on-site in the building interior:
 - 1. Adhesives, sealants, and sealer coatings.
 - 2. Carpet.
 - 3. Carpet cushion.
 - 4. Carpet tile.
 - 5. Resilient floor coverings.
 - 6. Paints and coatings.
 - 7. Insulation.
 - 8. Gypsum board.
 - 9. Acoustical ceilings and panels.
 - 10. Cabinet work.
 - 11. Composite wood and agrifiber products used either alone or as part of another product.
 - 12. Other products when specifically stated in the specifications.
- B. Interior of Building: Anywhere inside the exterior weather barrier.
- C. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.
- D. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

1.03 REFERENCE STANDARDS

- A. CAL (CHPS LEM) - Low-Emitting Materials Product List; California Collaborative for High Performance Schools (CHPS); current edition at www.chps.net/manual/lem_table.htm.
- B. CAL (VOC) - Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers (including Addendum 2004-01); State of California Department of Health Services; 2004.
- C. CRI (GLCC) - Green Label Testing Program - Approved Product Categories for Carpet Cushion; Carpet and Rug Institute; current listings at www.carpet-rug.org.
- D. CRI (GLP) - Green Label Plus Carpet Testing Program - Approved Products; Carpet and Rug Institute; current listings at www.carpet-rug.org.
- E. GEI (SCH) - GREENGUARD "Children and Schools" Certified Products; GREENGUARD Environmental Institute; current listings at www.greenguard.org.
- F. GreenSeal GS-36 - Commercial Adhesives; Green Seal, Inc.; 2000.
- G. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.
- H. SCS (CPD) - SCS Certified Products; Scientific Certification Systems; current listings at www.scs-certified.com.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Evidence of Compliance: Submit for each different product in each applicable category.
 - 1. Identify evidence submittals with the words "LEED Report".
- C. Product Data: For each VOC-restricted product used in the project, submit product data showing compliance, except when another type of evidence of compliance is required.
- D. Installer Certifications for Accessory Materials: Require each installer of any type of product (not just the products for which VOC restrictions are specified) to certify that either 1) no adhesives, joint sealants, paints, coatings, or composite wood or agrifiber products have been used in the installation of his products, or 2) that such products used comply with these requirements.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. All VOC-Restricted Products: Provide products having VOC content of types and volume not greater than those specified in State of California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions From Various Sources Using Small-Scale Environmental Chambers.
 - 1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Current GREENGUARD Children & Schools certification; www.greenguard.org.
 - b. Current Carpet and Rug Institute Green Label Plus certification; www.carpet-rug.org.
 - c. Current SCS Floorscore certification; www.scs-certified.com.
 - d. Current SCS Indoor Advantage Gold certification; www.scs-certified.com.
 - e. Product listing in the CHPS Low-Emitting Materials Product List at www.chps.net/manual/lem_table.htm.
 - f. Current certification by any other agencies acceptable to CHPS.
 - g. Report of laboratory testing performed in accordance with CHPS requirements for getting a product listed in the Low-Emitting Materials Product List; report must include laboratory's statement that the product meets the specified criteria.
 - 2. Product data submittals showing VOC content are NOT acceptable forms of evidence.

PART 3 EXECUTION**3.01 FIELD QUALITY CONTROL**

- A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.
- B. All additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION

SECTION 01732**WASTE MANAGEMENT****PART 1 GENERAL****1.01 WASTE MANAGEMENT REQUIREMENTS**

- A. Owner requires that this project generate the least amount of trash and waste possible.
- B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
- C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- D. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
 - 1. Aluminum and plastic beverage containers.
 - 2. Corrugated cardboard.
 - 3. Wood pallets.
 - 4. Clean dimensional wood: May be used as blocking or furring.
 - 5. Land clearing debris, including brush, branches, logs, and stumps: See Section 02230 for use options.
 - 6. Concrete: May be crushed and used as riprap, aggregate, sub-base material, or fill.
 - 7. Bricks: May be used on project if whole, or crushed and used as landscape cover, sub-base material, or fill.
 - 8. Concrete masonry units: May be used on project if whole, or crushed and used as sub-base material or fill.
 - 9. Precast concrete panels: May be used for erosion control or landscape features.
 - 10. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
 - 11. Glass.
 - 12. Gypsum drywall and plaster.
 - 13. Plastic buckets.
 - 14. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (<http://flooring.dupont.com>) and Interface (www.interfaceinc.com) conduct reclamation programs.
 - 15. Paint.
 - 16. Plastic sheeting.
 - 17. Rigid foam insulation.
 - 18. Windows, doors, and door hardware.
 - 19. Plumbing fixtures.
 - 20. Mechanical and electrical equipment.
 - 21. Fluorescent lamps (light bulbs).
 - 22. Acoustical ceiling tile and panels.
- E. LEED Certification for this project is dependent on diversion of 75 percent, by weight, of potential landfill trash/waste by recycling and/or salvage.
- F. The following recycling incentive programs are mandatory for this project; Contractor is responsible for implementation:
 - 1. _____: Revenue or savings shall accrue to Contractor.
- G. Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.
- H. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.

- I. The following sources may be useful in developing the Waste Management Plan:
 - 1. State Recycling Department, at _____.
 - 2. Recycling Haulers and Markets: The attached list contains local haulers and markets for recyclable materials. This list is provided for information only and is not necessarily comprehensive; other haulers and markets are acceptable.
- J. Methods of trash/waste disposal that are not acceptable are:
 - 1. Burning on the project site.
 - 2. Burying on the project site.
 - 3. Dumping or burying on other property, public or private.
 - 4. Other illegal dumping or burying.
 - 5. Incineration, either on- or off-site.
- K. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 DEFINITIONS

- A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
- C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
- D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
- E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
- H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- I. Return: To give back reusable items or unused products to vendors for credit.
- J. Reuse: To reuse a construction waste material in some manner on the project site.
- K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
- O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.

- B. LEED Submittals: Submit Landfill Alternatives Proposal, Waste Management Plan, and Waste Disposal Reports in accordance with procedures specified in Section 01355.
- C. Waste Management Plan: Include the following information:
1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
 2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
 3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
 4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
 5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
 6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.
 7. Recycling Incentives: Describe procedures required to obtain credits, rebates, or similar incentives.
- D. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
 2. Submit Report on a form acceptable to Owner.
 3. Landfill Disposal: Include the following information:
 - a. Identification of material.
 - b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
 - c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 4. Recycled and Salvaged Materials: Include the following information for each:
 - a. Identification of material, including those retrieved by installer for use on other projects.
 - b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
 - c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
 5. Material Reused on Project: Include the following information for each:
 - a. Identification of material and how it was used in the project.
 - b. Amount, in tons or cubic yards.
 - c. Include weight tickets as evidence of quantity.
 6. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.
- E. Recycling Incentive Programs:
1. Where revenue accrues to Contractor, submit copies of documentation required to qualify for incentive.
 2. Where revenue accrues to Owner, submit any additional documentation required by Owner in addition to information provided in periodic Waste Disposal Report.

PART 3 EXECUTION

2.01 WASTE MANAGEMENT PROCEDURES

- A. See Section 01300 for additional requirements for project meetings, reports, submittal procedures, and project documentation.
- B. See Section 01500 for additional requirements related to trash/waste collection and removal facilities and services.
- C. See Section 01600 for waste prevention requirements related to delivery, storage, and handling.
- D. See Section 01700 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

- A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.
- C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.
- D. Meetings: Discuss trash/waste management goals and issues at project meetings.
 - 1. Pre-bid meeting.
 - 2. Pre-construction meeting.
 - 3. Regular job-site meetings.
- E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
 - 1. As a minimum, provide:
 - a. Separate area for storage of materials to be reused on-site, such as wood cut-offs for blocking.
 - b. Separate dumpsters for each category of recyclable.
 - c. Recycling bins at worker lunch area.
 - 2. Provide containers as required.
 - 3. Provide temporary enclosures around piles of separated materials to be recycled or salvaged.
 - 4. Provide materials for barriers and enclosures that are nonhazardous, recyclable, or reusable to the maximum extent possible; reuse project construction waste materials if possible.
 - 5. Locate enclosures out of the way of construction traffic.
 - 6. Provide adequate space for pick-up and delivery and convenience to subcontractors.
 - 7. If an enclosed area is not provided, clearly lay out and label a specific area on-site.
 - 8. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
- F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.
- G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.
- H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.
- I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

SECTION 01734**INDOOR AIR QUALITY****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Construction procedures to promote adequate indoor air quality after construction.
- B. Building flush-out after construction and before occupancy.
- C. Testing indoor air quality after completion of construction.
- D. Testing air change effectiveness after completion of construction.

1.02 PROJECT GOALS

- A. Dust and Airborne Particulates: Prevent deposition of dust and other particulates in HVAC ducts and equipment.
 - 1. Cleaning of ductwork is not contemplated under this Contract.
 - 2. Contractor shall bear the cost of cleaning required due to failure to protect ducts and equipment from construction dust.
- B. Airborne Contaminants: Procedures and products have been specified to minimize indoor air pollutants.
 - 1. Furnish products meeting the specifications.
 - 2. Avoid construction practices that could result in contamination of installed products leading to indoor air pollution.
- C. Ventilation: HVAC system has been designed to achieve the minimum requirements for ventilation specified in ASHRAE 62.1.
- D. Ventilation: HVAC system has been designed to achieve the minimum requirements for ventilation specified in ASHRAE 62.1 with air change effectiveness of 0.9 or greater.

1.03 RELATED REQUIREMENTS

- A. Section 01355 - LEED Certification Procedures: LEED credits relating to indoor air quality.
- B. Section 01400 - Quality Requirements: Testing and inspection services.
- C. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.
- D. Section 15860 - Air Cleaning Devices: HVAC filters.
- E. Section 15950 - Testing, Adjusting, and Balancing: Testing HVAC systems for proper air flow rates, adjustment of dampers and registers, and settings for equipment.

1.04 REFERENCE STANDARDS

- A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2007.
- B. ASHRAE Std 62.1 - Ventilation For Acceptable Indoor Air Quality; 2007 (errata 2008).
- C. ASHRAE Std 129 - Measuring Air-Change Effectiveness; 1997 (Reaffirmed 2002).
- D. SMACNA (OCC) - IAQ Guideline for Occupied Buildings Under Construction; 2007.

1.05 DEFINITIONS

- A. Adsorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, fabrics, fibrous insulation, and other similar products.

- B. Contaminants: Gases, vapors, regulated pollutants, airborne mold and mildew, and the like, as specified.
- C. Particulates: Dust, dirt, and other airborne solid matter.
- D. Wet Work: Concrete, plaster, coatings, and other products that emit water vapor or volatile organic compounds during installation, drying, or curing.

1.06 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Indoor Air Quality Management Plan: Describe in detail measures to be taken to promote adequate indoor air quality upon completion; use SMACNA IAQ Guidelines for Occupied Buildings Under Construction as a guide.
 - 1. Submit not less than 60 days before enclosure of building.
 - 2. Identify potential sources of odor and dust.
 - 3. Identify construction activities likely to produce odor or dust.
 - 4. Identify areas of project potentially affected, especially occupied areas.
 - 5. Evaluate potential problems by severity and describe methods of control.
 - 6. Describe construction ventilation to be provided, including type and duration of ventilation, use of permanent HVAC systems, types of filters and schedule for replacement of filters.
 - 7. Describe cleaning and dust control procedures.
- C. Interior Finishes Installation Schedule: Identify each interior finish that either generates odors, moisture, or vapors or is susceptible to adsorption of odors and vapors, and indicate air handling zone, sequence of application, and curing times.
- D. Duct and Terminal Unit Inspection Report.
- E. Air Contaminant Test Plan: Identify:
 - 1. Testing agency qualifications.
 - 2. Locations and scheduling of air sampling.
 - 3. Test procedures, in detail.
 - 4. Test instruments and apparatus.
 - 5. Sampling methods.
- F. Air Contaminant Test Reports: Show:
 - 1. Location where each sample was taken, and time.
 - 2. Test values for each air sample; average the values of each set of 3.
 - 3. HVAC operating conditions.
 - 4. Certification of test equipment calibration.
 - 5. Other conditions or discrepancies that might have influenced results.
- G. Ventilation Effectiveness Test Plan: Identify:
 - 1. Testing agency qualifications.
 - 2. Description of test spaces, including locations of air sampling.
 - 3. Test procedures, in detail; state whether tracer gas decay or step-up will be used.
 - 4. Test instruments and apparatus; identify tracer gas to be used.
 - 5. Sampling methods.
- H. Ventilation Effectiveness Test Reports: Show:
 - 1. Include preliminary tests of instruments and apparatus and of test spaces.
 - 2. Calculation of ventilation effectiveness, E.
 - 3. Location where each sample was taken, and time.
 - 4. Test values for each air sample.
 - 5. HVAC operating conditions.
 - 6. Other information specified in ASHRAE 129.
 - 7. Other conditions or discrepancies that might have influenced results.

1.07 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: Independent testing agency having minimum of 5 years experience in performing the types of testing specified.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Low VOC Materials: See other sections for specific requirements for materials with low VOC content.
- B. Auxiliary Air Filters: MERV of 8, minimum, when tested in accordance with ASHRAE 52.2.

PART 3 EXECUTION

3.01 CONSTRUCTION PROCEDURES

- A. Prevent the absorption of moisture and humidity by adsorptive materials by:
 - 1. Sequencing the delivery of such materials so that they are not present in the building until wet work is completed and dry.
 - 2. Delivery and storage of such materials in fully sealed moisture-impermeable packaging.
 - 3. Provide sufficient ventilation for drying within reasonable time frame.
- B. Begin construction ventilation when building is substantially enclosed.
- C. If extremely dusty or dirty work must be conducted inside the building, shut down HVAC systems for the duration; remove dust and dirt completely before restarting systems.
- D. HVAC equipment and supply air ductwork may be used for ventilation during construction:
 - 1. Operate HVAC system on 100 percent outside air, with 1.5 air changes per hour, minimum.
 - 2. Ensure that air filters are correctly installed prior to starting use; replace filters when they lose efficiency.
 - 3. Do not use return air ductwork for ventilation.
 - 4. Seal return air inlets or otherwise positively isolate return air system to prevent recirculation of air; provide alternate return air pathways.
- E. Do not store construction materials or waste in mechanical or electrical rooms.
- F. Prior to use of return air ductwork without intake filters clean up and remove dust and debris generated by construction activities.
 - 1. Inspect duct intakes, return air grilles, and terminal units for dust.
 - 2. Clean plenum spaces, including top sides of lay-in ceilings, outsides of ducts, tops of pipes and conduit.
 - 3. Clean tops of doors and frames.
 - 4. Clean mechanical and electrical rooms, including tops of pipes, ducts, and conduit, equipment, and supports.
 - 5. Clean return plenums of air handling units.
 - 6. Remove intake filters last, after cleaning is complete.
- G. Do not perform dusty or dirty work after starting use of return air ducts without intake filters.
- H. Use other relevant recommendations of SMACNA IAQ Guideline for Occupied Buildings Under Construction for avoiding unnecessary contamination due to construction procedures.

3.02 BUILDING FLUSH-OUT

- A. Contractor's Option: Either full continuous flush-out OR satisfactory air contaminant testing is required, not both.
- B. Perform building flush-out before occupancy.
- C. Do not start flush-out until:
 - 1. All construction is complete.
 - 2. HVAC systems have been tested, adjusted, and balanced for proper operation.

3. Inspection of inside of return air ducts and terminal units confirms that cleaning is not necessary.
 4. New HVAC filtration media have been installed.
- D. Building Flush-Out: Operate all ventilation systems at normal flow rates with 100 percent outside air until a total air volume of 14,000 cubic feet per square foot of floor area has been supplied.
1. Obtain Owner's concurrence that construction is complete enough before beginning flush-out.
 2. Maintain interior temperature of at least 60 degrees F and interior relative humidity no higher than 60 percent.
 3. If additional construction involving materials that produce particulates or any of the specified contaminants is conducted during flush-out, start flush-out over.
 4. If interior spaces must be occupied prior to completion of the flush-out, supply a minimum of 25 percent of the total air volume prior to occupancy, and:
 - a. Begin ventilation at least three hours prior to daily occupancy.
 - b. Continue ventilation during all occupied periods.
 - c. Provide minimum outside air volume of 0.30 cfm per square foot or design minimum outside air rate, whichever is greater.
- E. Install new HVAC filtration media after completion of flush-out and before occupancy or further testing.

3.03 AIR CONTAMINANT TESTING

- A. Contractor's Option: Either full continuous flush-out OR satisfactory air contaminant testing is required, not both.
- B. Perform air contaminant testing before occupancy.
- C. Do not start air contaminant testing until:
1. All construction is complete, including interior finishes.
 2. HVAC systems have been tested, adjusted, and balanced for proper operation.
 3. New HVAC filtration media have been installed.
- D. Indoor Air Samples: Collect from spaces representative of occupied areas:
1. Collect samples while operable windows and exterior doors are closed, HVAC system is running normally as if occupied, with design minimum outdoor air, but with the building unoccupied.
 2. Collect samples from spaces in each contiguous floor area in each air handler zone, but not less than one sample per 25,000 square feet; take samples from areas having the least ventilation and those having the greatest presumed source strength.
 3. Collect samples from height from 36 inches to 72 inches above floor.
 4. Collect samples from same locations on 3 consecutive days during normal business hours; average the results of each set of 3 samples.
 5. Exception: Areas with normal very high outside air ventilation rates, such as laboratories, do not need to be tested.
 6. When retesting the same building areas, take samples from at least the same locations as in first test.
- E. Outdoor Air Samples: Collect samples at outside air intake of each air handler at the same time as indoor samples are taken.
- F. Analyze air samples and submit report.
- G. Air Contaminant Concentration Determination and Limits:
1. Carbon Monoxide: Not more than 9 parts per million and not more than 2 parts per million higher than outdoor air.
 2. Airborne Mold and Mildew: Measure in relation to outside air; not higher than outside air.
 3. Formaldehyde: Not more than 50 parts per billion.
 4. Formaldehyde: Measure in micrograms per cubic meter, in relation to outside air; not more than 20 micrograms per cubic meter higher than outside air.
 5. Total Volatile Organic Compounds (TVOC): Not more than 500 micrograms per cubic meter.
 6. Total Volatile Organic Compounds (TVOC): Measure in micrograms per cubic meter, in relation to outside air; not more than 200 micrograms per cubic meter higher than outside air.

7. Particulates (PM10): Not more than 50 micrograms per cubic meter.
8. Total Particulates (PM): Measure in micrograms per cubic meter, in relation to outside air; not more than 20 micrograms per cubic meter higher than outside air.

3.04 VENTILATION EFFECTIVENESS TESTING

- A. Perform ventilation effectiveness testing before occupancy.
- B. Do not begin ventilation effectiveness testing until:
 1. HVAC testing, adjusting, and balancing has been satisfactorily completed.
 2. Building flush-out or air contaminant testing has been completed satisfactorily.
 3. New HVAC filtration media have been installed.
- C. Test each air handler zone in accordance with ASHRAE 129.
- D. If calculated air change effectiveness for a particular zone is less than 0.9 due to inadequate balancing of the system, adjust, and retest at no cost to Owner.

END OF SECTION

SECTION 01780**CLOSEOUT SUBMITTALS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Section 01300 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Individual Product Sections: Specific requirements for operation and maintenance data.
- C. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 4. Submit two sets of revised final documents in final form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 3 EXECUTION**2.01 PROJECT RECORD DOCUMENTS**

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.

- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish first floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original Contract drawings.

2.02 OPERATION AND MAINTENANCE DATA

- A. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

2.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
 - 2. Information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Additional information as specified in individual product specification sections.
- E. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

2.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- C. Include color coded wiring diagrams as installed.

- D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- E. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- F. Provide servicing and lubrication schedule, and list of lubricants required.
- G. Include manufacturer's printed operation and maintenance instructions.
- H. Include sequence of operation by controls manufacturer.
- I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- J. Provide control diagrams by controls manufacturer as installed.
- K. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
- L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- M. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- N. Include test and balancing reports.
- O. Additional Requirements: As specified in individual product specification sections.

2.05 OPERATION AND MAINTENANCE MANUALS

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- B. Prepare data in the form of an instructional manual.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Photocopies of warranties and bonds.

- E. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.
- F. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Architect, Consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

2.06 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.
- E. Include originals of each in operation and maintenance manuals, indexed separately on Table of Contents.

END OF SECTION

SECTION 01810**COMMISSIONING****PART 1 GENERAL****1.01 SUMMARY**

- A. Commissioning is intended to achieve the following specific objectives; this section specifies the Contractor's responsibilities for commissioning:
 - 1. Verify that the work is installed in accordance with the Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports and Prefunctional Checklists executed by Contractor are utilized to achieve this.
 - 2. Verify and document that functional performance is in accordance with the Contract Documents: Functional Tests executed by Contractor and witnessed by the Commissioning Authority are utilized to achieve this.
 - 3. Verify that operation and maintenance manuals submitted to Owner are complete: Detailed operation and maintenance (O&M) data submittals by Contractor are utilized to achieve this.
 - 4. Verify that the Owner's operating personnel are adequately trained: Formal training conducted by Contractor is utilized to achieve this.
- B. Commissioning, including Functional Tests, O&M documentation review, and training, is to occur after startup and initial checkout and be completed before Substantial Completion
- C. The Commissioning Authority directs and coordinates all commissioning activities; this section describes some but not all of the Commissioning Authority's responsibilities.
- D. The Commissioning Authority is employed by Owner.

1.02 SCOPE OF COMMISSIONING

- A. The following are to be commissioned:
- B. Plumbing Systems:
 - 1. Water heaters.
 - 2. Booster pumps.
 - 3. Landscape irrigation.
- C. HVAC System, including:
 - 1. Major and minor equipment items.
 - 2. Piping systems and equipment.
 - 3. Ductwork and accessories.
 - 4. Terminal units.
 - 5. Control system.
 - 6. Sound control devices.
 - 7. Vibration control devices.
 - 8. Variable frequency drives.
- D. Special Ventilation:
 - 1. Fume hoods.
 - 2. Laboratory pressurization.
 - 3. Specialty fans.
 - 4. Egress pressurization.
- E. Electrical Systems:
 - 1. Power quality.
 - 2. Emergency power systems.
 - 3. Uninterruptible power systems.
 - 4. Lighting controls other than manual switches.

- F. Electronic Safety and Security:
 - 1. Security system, including doors and hardware.
 - 2. Fire and smoke alarms.
- G. Communications:
 - 1. Voice and data systems.
 - 2. Public address/paging.
- H. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- I. Indoor Air Quality Procedures: The Commissioning Authority will coordinate; Contractor will execute; see Section 01734.

1.03 RELATED REQUIREMENTS

- A. Section 01355 - LEED Certification Procedures: LEED credits relating to commissioning.
- B. Section 01734 - Indoor Air Quality: Precautions and procedures; smoking room testing; building flush-out.
- C. Section 01780 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.
- D. Section 01820 - Demonstration and Training: Scope and procedures for Owner personnel training.
- E. Section 01815 - Commissioning Authority Responsibilities.
- F. Section 15012 - Commissioning of HVAC: HVAC control system testing; other requirements.

1.04 REFERENCE STANDARDS

- A. PECCI (Samples) - Sample Forms for Prefunctional Checklists and Functional Performance Tests; Portland Energy Conservation, Inc.; located at <http://www.peci.org/library/mcpgs.htm>; current edition.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures; except:
 - 1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority, unless they require review by Architect; in that case, submit to Architect first.
 - 2. Submit one copy to the Commissioning Authority, not to be returned.
 - 3. Make commissioning submittals on time schedule specified by Commissioning Authority.
 - 4. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of Prefunctional Checklists or Functional Test requirements; submit in editable electronic format, Microsoft Word 2003 preferred.
 - 5. As soon as possible after submittals made to Architect are approved, submit copy of approved submittal to the Commissioning Authority.
 - 6. LEED Submittals: Submit approved submittals in accordance with procedures specified in Section 01355.
- B. Manufacturers' Instructions: Submit copies of all manufacturer-provided instructions that are shipped with the equipment as soon as the equipment is delivered.
- C. Product Data: If submittals to Architect do not include the following, submit copies as soon as possible:
 - 1. Manufacturer's product data, cut sheets, and shop drawings.
 - 2. Manufacturer's installation instructions.
 - 3. Startup, operating, and troubleshooting procedures.
 - 4. Fan and pump curves.
 - 5. Factory test reports.

6. Warranty information, including details of Owner's responsibilities in regard to keeping warranties in force.
- D. Startup Plans and Reports.
- E. Completed Prefunctional Checklists.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
 1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F and resolution of plus/minus 0.1 degree F.
 2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
 3. Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.
- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.
- D. Dataloggers: Independent equipment and software for monitoring flows, currents, status, pressures, etc. of equipment.
 1. Dataloggers required to for Functional Tests will be provided by the Commissioning Authority and will not become the property of Owner.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN

- A. Commissioning Authority has prepared the Commissioning Plan.
 1. Attend meetings called by the Commissioning Authority for purposes of completing the commissioning plan.
 2. Require attendance and participation of relevant subcontractors, installers, suppliers, and manufacturer representatives.
- B. Contractor is responsible for compliance with the Commissioning Plan.
- C. Commissioning Plan: The commissioning schedule, procedures, and coordination requirements for all parties in the commissioning process.
- D. Commissioning Schedule:
 1. Submit anticipated dates of startup of each item of equipment and system to Commissioning Authority within 60 days after award of Contract.
 2. Re-submit anticipated startup dates monthly, but not less than 4 weeks prior to startup.
 3. Prefunctional Checklists and Functional Tests are to be performed in sequence from components, to subsystems, to systems.
 4. Provide sufficient notice to Commissioning Authority for delivery of relevant Checklists and Functional Test procedures, to avoid delay.

3.02 DOCUMENTATION IDENTIFICATION SYSTEM

- A. Give each submitted form or report a unique identification; use the following scheme.

- B. Type of Document: Use the following prefixes:
 - 1. Startup Plan: SP-
 - 2. Startup Report: SR-
 - 3. Prefunctional Checklist: PC-
 - 4. Functional Test Procedure: FTP-
 - 5. Functional Test Report: FTR-
- C. System Type: Use the first 4 digits from CSI/CSC MasterFormat, 2004 Edition, that are applicable to the system; for example:
 - 1. 2300: HVAC system as a whole.
 - 2. 2320: HVAC Piping and Pumps.
 - 3. 2330: HVAC Air Distribution.
- D. Component Number: Assign numbers sequentially, using 1, 2, or 3 digits as required to accommodate the number of units in the system.
- E. Test, Revision, or Submittal Number: Number each successive iteration sequentially, starting with 1.
- F. Example: PC-2320-001.2 would be the Prefunctional Checklist for equipment item 1 in the HVAC piping system, probably a pump; this is the second, revised submittal of this checklist.

3.03 STARTUP PLANS AND REPORTS

- A. Startup Plans: For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 8 weeks prior to startup.
- B. Startup Reports: For each item of equipment and system for which the manufacturer provides a startup checklist (or startup plan or field checkout sheet), document compliance by submitting the completed startup checklist prior to startup, signed and dated by responsible entity.
- C. Submit directly to the Commissioning Authority.

3.04 PREFUNCTIONAL CHECKLISTS

- A. A Prefunctional Checklist is required to be filled out for each item of equipment or other assembly specified to be commissioned.
 - 1. No sampling of identical or near-identical items is allowed.
 - 2. These checklists do not replace manufacturers' recommended startup checklists, regardless of apparent redundancy.
 - 3. Prefunctional Checklist forms will not be complete until after award of the contract; the following types of information will be gathered via the completed Checklist forms:
 - a. Certification by installing contractor that the unit is properly installed, started up, and operating and ready for Functional Testing.
 - b. Confirmation of receipt of each shop drawing and commissioning submittal specified, itemized by unit.
 - c. Manufacturer, model number, and relevant capacity information; list information "as specified," "as submitted," and "as installed."
 - d. Serial number of installed unit.
 - e. List of inspections to be conducted to document proper installation prior to startup and Functional Testing; these will be primarily static inspections and procedures; for equipment and systems may include normal manufacturer's start-up checklist items and minor testing.
 - f. Sensor and actuator calibration information.
 - 4. Samples of Prefunctional Checklist forms that indicate anticipated level of detail can be found at <http://www.peci.org/library/mcpgs.htm>.
- B. Contractor is responsible for filling out Prefunctional Checklists, after completion of installation and before startup; witnessing by the Commissioning Authority is not required unless otherwise specified.

1. Each line item without deficiency is to be witnessed, initialed, and dated by the actual witness; checklists are not complete until all line items are initialed and dated complete without deficiencies.
 2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing; re-submission of the Checklist is required upon completion of remaining items.
 3. Individual Checklists may contain line items that are the responsibility of more than one installer; Contractor shall assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.
 4. If any Checklist line item is not relevant, record reasons on the form.
 5. Contractor may independently perform startup inspections and/or tests, at his option.
 6. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.
 7. Submit completed Checklists to Commissioning Authority within two days of completion.
- C. Commissioning Authority is responsible for furnishing the Prefunctional Checklists to Contractor.
1. Initial Drafts: Contractor is responsible for initial draft of Prefunctional Checklist where so indicated in the Contract Documents.
 2. Provide all additional information requested by Commissioning Authority to aid in preparation of checklists, such as shop drawing submittals, manufacturers' startup checklists, and O&M data.
 3. Commissioning Authority may add any relevant items deemed necessary regardless of whether they are explicitly mentioned in the Contract Documents or not.
 4. When asked to review the proposed Checklists, do so in a timely manner.
- D. Commissioning Authority Witnessing: Required for:
1. Each piece of primary equipment, unless sampling of multiple similar units is allowed by the commissioning plan.
 2. A sampling of non-primary equipment, as allowed by the commissioning plan.
- E. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.
1. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.05 FUNCTIONAL TESTS

- A. A Functional Test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.
- B. Contractor is responsible for execution of required Functional Tests, after completion of Prefunctional Checklist and before closeout.
- C. Commissioning Authority is responsible for witnessing and reporting results of Functional Tests, including preparation and completion of forms for that purpose.
- D. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Owner; if a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and the Contractor's stated intentions regarding correction.
1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents or does not perform properly.
 2. When the deficiency has been corrected, the Contractor completes the form certifying that the item is ready to be re-tested and returns the form to the Commissioning Authority; the Commissioning Authority will reschedule the test and the Contractor shall re-test.
 3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
 4. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing

- re-testing.
5. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing re-testing if the test failed due to failure to execute the relevant Prefunctional Checklist correctly; if the test failed for reasons that would not have been identified in the Prefunctional Checklist process, Contractor shall bear the cost of the second and subsequent re-tests.
- E. Functional Test Procedures:
1. Some test procedures are included in the Contract Documents; where Functional Test procedures are not included in the Contract Documents, test procedures will be determined by the Commissioning Authority with input by and coordination with Contractor.
 2. Examples of Functional Testing:
 - a. Test the dynamic function and operation of equipment and systems (rather than just components) using manual (direct observation) or monitoring methods under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint).
 - b. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc.
 - c. Systems are run through all the HVAC control system's sequences of operation and components are verified to be responding as the sequence's state.
 - d. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Commissioning Authority is Functional Testing.
 3. Samples of Functional Test forms that indicate anticipated level of detail can be found at <http://www.peci.org/library/mcpgs.htm>.
- F. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions; performance of these tests remains the Contractor's responsibility regardless of timing.

3.06 SENSOR AND ACTUATOR CALIBRATION

- A. Calibrate all field-installed temperature, relative humidity, carbon monoxide, carbon dioxide, and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
- B. Calibrate using the methods described below; alternate methods may be used, if approved by Owner beforehand. See PART 2 for test instrument requirements. Record methods used on the relevant Prefunctional Checklist or other suitable forms, documenting initial, intermediate and final results.
- C. All Sensors:
1. Verify that sensor location is appropriate and away from potential causes of erratic operation.
 2. Verify that sensors with shielded cable are grounded only at one end.
 3. For sensor pairs that are used to determine a temperature or pressure difference, for temperature make sure they are reading within 0.2 degree F of each other, and for pressure, within tolerance equal to 2 percent of the reading, of each other.
 4. Tolerances for critical applications may be tighter.
- D. Sensors Without Transmitters - Standard Application:
1. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
 2. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
 3. If not, install offset, calibrate or replace sensor.
- E. Sensors With Transmitters - Standard Application.
1. Disconnect sensor.
 2. Connect a signal generator in place of sensor.
 3. Connect ammeter in series between transmitter and building automation system control panel.
 4. Using manufacturer's resistance-temperature data, simulate minimum desired temperature.

5. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter.
 6. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the building automation system.
 7. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction.
 8. Reconnect sensor.
 9. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
 10. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
 11. If not, replace sensor and repeat.
 12. For pressure sensors, perform a similar process with a suitable signal generator.
- F. Sensor Tolerances for Standard Applications: Plus/minus the following maximums:
1. Watthour, Voltage, Amperage: 1 percent of design.
 2. Pressure, Air, Water, Gas: 3 percent of design.
 3. Air Temperatures (Outside Air, Space Air, Duct Air): 0.4 degrees F.
 4. Relative Humidity: 4 percent of design.
 5. Barometric Pressure: 0.1 inch of Hg (.
 6. Flow Rate, Air: 10 percent of design.
 7. Flow Rate, Water: 4 percent of design.
 8. AHU Wet Bulb and Dew Point: 2.0 degrees F.
- G. Critical Applications: For some applications more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.
- H. Valve/Damper Stroke Setup and Check:
1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 2. Set pump/fan to normal operating mode.
 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
 4. Command valve/damper to open; verify position is full open and adjust output signal as required.
 5. Command valve/damper to a few intermediate positions.
 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- I. Isolation Valve or System Valve Leak Check: For valves not associated with coils.
1. With full pressure in the system, command valve closed.
 2. Use an ultra-sonic flow meter to detect flow or leakage.

3.07 TEST PROCEDURES - GENERAL

- A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.
- C. Sampling: Where Functional Testing of fewer than the total number of multiple identical or near-identical items is explicitly permitted, perform sampling as follows:
1. Identical Units: Defined as units with same application and sequence of operation; only minor size or capacity difference.
 2. Sampling is not allowed for:
 - a. Major equipment.
 - b. Life-safety-critical equipment.
 - c. Prefunctional Checklist execution.
 3. XX = the percent of the group of identical equipment to be included in each sample; defined for

- specific type of equipment.
4. YY = the percent of the sample that if failed will require another sample to be tested; defined for specific type of equipment.
 5. Randomly test at least XX percent of each group of identical equipment, but not less than three units. This constitutes the "first sample."
 6. If YY percent of the units in the first sample fail, test another XX percent of the remaining identical units.
 7. If YY percent of the units in the second sample fail, test all remaining identical units.
 8. If frequent failures occur, resulting in more troubleshooting than testing, the Commissioning Authority may stop the testing and require Contractor to perform and document a checkout of the remaining units prior to continuing testing.
- D. Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- E. Simulating Conditions: Artificially create the necessary condition for the purpose of testing the response of a system; for example apply hot air to a space sensor using a hair dryer to see the response in a VAV box.
- F. Simulating Signals: Disconnect the sensor and use a signal generator to send an amperage, resistance or pressure to the transducer and control system to simulate the sensor value.
- G. Over-Writing Values: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation.
- H. Indirect Indicators: Remote indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed, are considered indirect indicators.
- I. Monitoring: Record parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of the relevant control systems; where monitoring of specific points is called for in Functional Test Procedures:
1. All points that are monitored by the relevant control system shall be trended by Contractor; at the Commissioning Authority's request, Contractor shall trend up to 20 percent more points than specified at no extra charge.
 2. Other points will be monitored by the Commissioning Authority using dataloggers.
 3. At the option of the Commissioning Authority, some control system monitoring may be replaced with datalogger monitoring.
 4. Provide hard copies of monitored data in columnar format with time down left column and at least 5 columns of point values on same page.
 5. Graphical output is desirable and is required for all output if the system can produce it.
 6. Monitoring may be used to augment manual testing.

3.08 OPERATION AND MAINTENANCE MANUALS

- A. See Section 01780 for additional requirements.
- B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

END OF SECTION

SECTION 01815**COMMISSIONING AUTHORITY RESPONSIBILITIES****PART 1 GENERAL****1.01 SUMMARY**

- A. Commissioning is intended to achieve the following specific objectives; this section covers the Commissioning Authority's responsibilities for commissioning:
 - 1. Verify that the work is installed in accordance with the Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports and Prefunctional Checklists are utilized to achieve this.
 - 2. Verify and document that functional performance is in accordance with the Contract Documents: Functional Tests performed by Contractor and witnessed by the Commissioning Authority are utilized to achieve this.
 - 3. Verify that operation and maintenance manuals submitted to Owner are complete: Detailed O&M data submittals are specified.
 - 4. Verify that the Owner's operating personnel are adequately trained: Formal training conducted by Contractor is specified.
- B. Commissioning, including Functional Tests, O&M documentation review, and training, is to occur after startup and initial checkout and be completed before Substantial Completion.
- C. Coordinate and direct all the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
- D. The Commissioning Authority is to be employed by Owner.
- E. The scope of commissioning activities is defined in Section 01810 - Commissioning.
- F. Contractor's responsibilities are defined in Section 01810 - Commissioning.

1.02 REFERENCE STANDARDS

- A. ASHRAE Guideline 1 - The HVAC Commissioning Process; 1996
- B. PECI (MCP) - Model Commissioning Plan; Portland Energy Conservation, Inc.; located at <http://www.peci.org/library/mcpgs.htm>; current edition.

1.03 SUBMITTALS

- A. Commissioning Plan:
 - 1. Submit preliminary draft for review by Owner and Architect within 30 days after commencement of Commissioning Authority contract.
 - 2. Submit final plan not more than 90 days after commencement of construction, for issuance to all parties.
- B. General Commissioning Specifications.
 - 1. Submit preliminary draft for review by Owner and Architect at start of construction documents phase or within 30 days after commencement of Commissioning Authority contract, whichever is later.
 - 2. Submit final draft for review by Owner and Architect not less than 6 weeks prior to bid date.
- C. List of Prefunctional Checklists to be developed:
 - 1. Submit preliminary list at start of construction documents phase or within 30 days after commencement of contract, whichever is later.
 - 2. Submit final list not more than 60 days after start of construction.
- D. Prefunctional Checklists:

1. Submit preliminary draft at start of construction documents phase or within 30 days after commencement of contract, whichever is later.
 2. Submit final draft to Contractor not less than 4 weeks prior to startup of particular items to be commissioned.
- E. List of Functional Test procedures to be developed:
1. Submit preliminary list at start of construction documents phase or within 30 days after commencement of contract, whichever is later.
 2. Submit final list not more than 60 days after start of construction.
- F. Functional Test Procedures:
1. Submit preliminary draft at start of construction documents phase or within 30 days after commencement of contract, whichever is later.
 2. Submit final draft to Contractor not less than 4 weeks prior to startup of particular items to be commissioned.
- G. Training Plan.
- H. Commissioning Record: Submit to Contractor for inclusion with O&M manuals.
- I. Final Commissioning Report: Submit to Owner.
- J. Recommissioning Manual: Submit within 60 days after receipt of Owner's instructions to proceed with preparation.
- K. LEED Reports: Submit Final Commissioning Report and Recommissioning Manual in accordance with procedures specified in Section 01355.

PART 2 PRODUCTS

2.01 DOCUMENTATION IDENTIFICATION SYSTEM

- A. Give each submitted form or report a unique identification; use the following scheme.
- B. Type of Document: Use the following prefixes:
1. Commissioning Plan: CP-.
 2. Prefunctional Checklist: PC-.
 3. Functional Test Procedure: FTP-.
 4. Functional Test Report: FTR-.
 5. Commissioning Report: CR-.
- C. System Type: Use the first 4 digits from CSI/CSC MasterFormat, 2004 Edition, that are applicable to the system; for example:
1. 2300: HVAC system as a whole.
 2. 2320: HVAC Piping and Pumps.
 3. 2330: HVAC Air Distribution.
- D. Component Number: Assign numbers sequentially, using 1, 2, or 3 digits as required to accommodate the number of units in the system.
- E. Test, Revision, or Submittal Number: Number each successive iteration sequentially, starting with 1.
- F. Example: PC-2320-001.2 would be the Prefunctional Checklist for equipment item 1 in the HVAC piping system, probably a pump; this is the second, revised submittal of this checklist.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN

- A. Prepare and maintain the Commissioning Plan, covering commissioning schedule, Prefunctional Checklist and Functional Test procedures, coordination requirements, and forms to be used, for all parties in the commissioning process.
1. Call and chair meetings of the Commissioning Team when appropriate.

2. Give Contractor sufficient notice for scheduling commissioning activities.
 3. Develop a comprehensive start-up and initial systems checkout plan with cooperation of Contractor and subcontractors.
 4. The PECE Model Commissioning Plan may be used as a guide for the Commissioning Plan.
 5. ASHRAE Guideline 1 may be used as a guide for the Commissioning Plan.
 6. Avoid replication of information included in the construction contract documents to the greatest extent possible.
- B. Basis of Design Documentation: Detailed documentation of the functional requirements of the project; descriptions of the systems, components, and methods chosen to meet the design intent; assumptions underlying the design intent.
- C. Review the construction contract documents for Contractor submittals of draft checklists, draft test procedures, manufacturer startup procedures, and other information intended for the use of the Commissioning Authority in preparing the Commissioning Plan.
- D. Commissioning Schedule:
1. Coordinate with Contractor anticipated dates of startup of each item of equipment and system.
 2. Contractor's scheduling responsibilities are specified in the construction contract documents.
 3. Revise and re-issue schedule monthly.
 4. Prefunctional Checklists and Functional Tests are to be performed in sequence from components, to subsystems, to systems.
 5. Deliver relevant Prefunctional Checklists and Functional Test Procedures to Contractor in time to avoid delay.

3.02 CONSTRUCTION CONTRACT DOCUMENTS

- A. General Commissioning Specifications: Prepare general commissioning specifications coordinated with and integrated into the Contract Documents prepared by Architect.
1. Include general procedures applicable to all types of items to be commissioned and specific procedures for each type of work.
 2. Identify Contractor submittals needed for purposes of commissioning, that are not otherwise required to be submitted.
- B. Prefunctional Checklists: Develop detailed Checklists for each item to be commissioned.
1. List of Checklists to be Developed: Prepare and maintain a detailed list of titles, not full text.
 2. The Checklist forms are intended to be part of the Contractor's Contract Documents.
- C. Functional Testing: Develop detailed procedures for each item to be commissioned; submit for review by Owner and Architect.
1. List of Test Procedures to be Developed: Prepare and maintain a detailed list of titles, not full text.
 2. The forms the Commissioning Authority will use to report Functional Test results are not intended to be part of Contractor's Contract Documents, but the Functional Test Procedures that must be executed by the Contractor must be made part of the Contract Documents, by modification if necessary.
- D. Develop any other reporting forms Contractor will be required to use; if they are likely to require a substantially different amount of work than the Contractor can reasonably anticipate, they must be included in the construction contract documents.
- E. If any part of the documents described above have not been developed by the bid date, coordinate with Architect the issuance of modifications to the construction contract documents

3.03 PREFUNCTIONAL CHECKLISTS

- A. Prefunctional Checklists - Content: Prepare forms for Contractor's use, in sufficient detail to document that the work has been installed in accordance with the Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup.

1. Prepare separate Checklists for each type of equipment, system, or other assembly, customized to the item.
 2. Identify each Checklist by using the contract documents identification number or name, if any; if none, create unique identifiers for each Checklist; do not rely on Contractor to number checklists.
 3. Multiple identical or near-identical items may appear on a single Checklist provided there is space to record all required data for each separately; label each set of data uniquely.
 4. Include space to record manufacturer name, model number, serial number, capacity and other relevant characteristics, and accessories and other features as applicable; include space to record "as specified", "as submitted", and "as installed" data.
 5. Include space to record whether or not the required submittals have been received; list each separate type of submittal.
 6. Include line items for each physical inspection to be performed.
 7. Include line items for each operational inspection to be performed, such as checking switch operation, fan rotation, valve and damper stroke, and measuring actual electrical loads.
 8. Include separate section for sensors and actuators, with space for documenting actual physical location and calibration measurements; provide a separate generic calibration checklist identified wherever referenced.
 9. Include spaces to record that related Checklists for related work upon which this work depends have been completed.
- B. Prefunctional Checklists - Format:
1. Provide a cover sheet showing name of equipment item or system, documentation identification number (see Documentation Identification Scheme), names of accessory components involved, and identification of related checklists.
 2. Include on cover sheet space for Contractor's use in attesting to completeness; provide spaces for the signatures of the general contractor and each subcontractor or other entity responsible, customized to the project and the type of item.
 3. Include on the cover sheet, above the signature block, the following statement: "The work referenced in this Checklist and other work integral to or dependent on this work is complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event." Include two checkboxes:
 - a. "This Checklist is submitted for approval with no exceptions."
 - b. "This Checklist is submitted for approval, subject to the attached list of outstanding items, none of which preclude the performance of safe and reliable functional tests. A statement of completion will be submitted upon completion of the outstanding items."
 4. Use a consistent, tabular format for all Checklists, with one line per checklist activity.
 5. For each line item, provide space for initials and date, and identification of the subcontractor or other entity responsible.

3.04 FUNCTIONAL TEST PROCEDURES

- A. Develop test procedures in sufficient detail to show that functional performance is in accordance with the Contract Documents and shows proper operation through all modes of operation where there is a different system response, including seasonal, unoccupied, warm-up, cool-down, part- and full-load.
1. Obtain assistance and review by installing subcontractors.
 2. Itemize each test sequence in step-by-step order, with acceptance criteria for each step and for the test as a whole.
 3. Include test setup instructions, description of tools and apparatus, special cautions, and.
 4. Avoid procedures that would void or otherwise limit warranties; review with Contractor prior to execution.
 5. For HVAC systems, procedures may include energy management control system trending, stand-alone datalogger monitoring or manual functional testing.
 6. Obtain explicit approval of Contractor in regard to feasibility and safety prior to execution.
- B. Functional Test Report Forms: Prepare forms in advance of testing, using a consistent format; include all test procedure information given to Contractor and:

1. Report Identifier (see Documentation Identification Scheme).
 2. Test prerequisites.
 3. Formulas to be used in calculations.
 4. Yes/No check boxes for each step of test.
 5. Space to record results, document deficiencies, and make recommendations.
 6. Signature and date block for Commissioning Authority.
- C. Functional Test Prerequisites: Include space to verify all of the following items on each Functional Test Report Form, unless truly inapplicable:
1. All related equipment has been started up and start-up reports and Prefunctional Checklists submitted and approved ready for Functional Testing.
 - a. For hydronic systems, check that:
 - 1) Piping system flushing is complete and required report approved.
 - 2) Water treatment system is complete and operational.
 - 3) Test and balance (TAB) is complete and approved.
 2. All control system functions for this and all interlocking systems are programmed and operable in accordance with the Contract Documents, including final set points and schedules with debugging, loop tuning and sensor calibrations completed, with space for signature of controls installer.
 3. Incomplete items identified by Architect during closeout inspections have been corrected or completed.
 4. Safeties and operating ranges have been reviewed.
 5. A copy of the specified sequence of operation is attached.
 6. A copy of applicable schedules and setpoints is attached.
 7. A copy of the specified Functional Test Procedures is attached.
 8. The Functional Test Procedures have been reviewed and approved by the applicable installer.
 9. Vibration control report approved (if required).
 10. False loading equipment, system and procedures ready.
 11. Sufficient clearance around equipment for servicing.
 12. Original values of pre-test setpoints that need to be changed to accommodate testing have been recorded, with a check box provided to verify return to original values (include control parameters, limits, delays, lockouts, schedules, etc.).
 13. Any other items on the Prefunctional Checklist or Start-up Reports that need to be re-verified.

3.05 CONSTRUCTION PHASE

- A. Coordinate the commissioning work with Contractor and Construction Manager, ensure that commissioning activities are being incorporated into the master schedule.
- B. Perform site visits, as necessary, to observe component and system installations. Attend planning and job-site meetings to obtain information on construction progress. Review Contractor's meeting minutes for issues relating to the commissioning process. Assist in resolving discrepancies.
- C. Commissioning Kick-Off Meeting: Plan and conduct a meeting early in the construction phase to review commissioning activities and responsibilities with all parties involved. Require attendance by all members of the Commissioning Team.
- D. Conduct periodic meetings as necessary to coordinate, resolve planning issues, and aid in resolution of deficiencies, minimizing the time spent by Contractor and Owner personnel; hold meetings at least monthly.
- E. Submit periodic progress reports to Owner and Contractor.
- F. Review Contractor shop drawing submittals applicable to systems being commissioned for compliance with commissioning needs; verify that Owner's responsibilities are clearly defined in warranties.
- G. Review and approve submittals directly related to commissioning.
- H. Deliver Prefunctional Checklists and Functional Test procedures to Contractor.

- I. Verify satisfactory completion of Prefunctional Checklists by Contractor by reviewing checklists and by site observation and spot checking; provide formal approval when satisfactory.
- J. Verify startup of all systems by reviewing start-up reports and by site observation; provide formal approval when satisfactory.
- K. Coordinate, witness and approve Functional Tests performed by Contractor. Coordinate retesting until satisfactory performance is achieved.
- L. HVAC Commissioning:
 - 1. Gather and review the control sequences and interlocks and work with Contractor and design engineers until sufficient clarity has been obtained, in writing, to be able to prepare detailed Functional Test procedures.
 - 2. Witness all or part of HVAC piping test and flushing procedures, sufficient to be confident that proper procedures were followed; document testing and include documentation in O&M manuals.
 - 3. Witness all or part of duct testing and cleaning procedures, sufficient to be confident that proper procedures were followed; document testing and include documentation in O&M manuals.
 - 4. Review TAB Plan prepared by Contractor.
 - 5. Before TAB is executed, witness sufficient Functional Testing of the control system to approve it to be used for TAB.
 - 6. Verify air and water systems balancing by spot testing, by reviewing completed reports, and by site observation; provide formal approval when satisfactory.
 - 7. Analyze trend logs and monitoring data to verify performance.
- M. Witness and document testing of systems and components over which the Commissioning Authority does not have direct control, such as smoke control systems, tests contracted directly by Owner, and tests by manufacturer's personnel; include documentation in O&M manuals.
- N. Perform Functional Testing for systems and equipment so specified, without assistance of Contractor.
- O. Maintain a master deficiency and resolution log and a separate testing record. Provide written progress and test reports with recommended actions.
- P. O&M Data: Review submitted operation and maintenance data for completeness; provide formal approval if satisfactory.
- Q. Notify Contractor and Owner of deficiencies in procedures or results; suggest solutions.

3.06 TRAINING

- A. Training Plan: Prepare a comprehensive Training Plan, incorporating draft training plans submitted by Contractor.
 - 1. Include a ____ hour session by the HVAC design engineer covering the overall HVAC system and equipment design concepts, with one-line schematic drawings.
 - 2. Include a ____ hour session by the Commissioning Authority on the use of the blank Prefunctional Checklists and Functional Test report forms for re-commissioning purposes.
 - 3. Establish criteria for determining satisfactory completion of training.
- B. Verify that training was satisfactorily completed; provide formal approval if satisfactory.

3.07 CLOSEOUT

- A. Commissioning Record: Use the same format and organization as specified for the O&M manuals.
 - 1. Include the Final Commissioning Plan and Final Report.
 - 2. For each product or system and equipment item, include the following organized as indicated, with separator tabs:
 - a. Design intent documentation, furnished by Architect or others.
 - b. Detailed operational sequences.
 - c. Startup plan and approved startup reports.
 - d. Filled out Prefunctional Checklists.

- e. Filled out Functional Test reports; trend logs and monitoring reports and analysis; other verification documentation.
 - f. Training plan and training records.
 - g. Recommissioning recommendations, including time schedule and procedures; include blank copies of all Prefunctional Checklists and Functional Test report forms.
- B. Final Commissioning Report: Include:
1. Executive summary.
 2. List of participants and roles.
 3. Brief facility description.
 4. Overview of commissioning scope and general description of testing and verification methods.
 5. For each item commissioned, an evaluation of adequacy of:
 - a. The product itself; i.e. compliance with the contract documents.
 - b. Installation.
 - c. Functional performance; include a brief description of the verification method used and observations and conclusions from the testing.
 - d. O&M documentation, including design intent.
 - e. Operator training.
 6. List of all outstanding non-compliance items, referenced to the specific functional test, inspection, trend log, etc., where the deficiency is documented.
 7. List of unresolved issues, seasonal or deferred testing, and other concerns that could affect facility operation.
 8. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. (about four to six pages).
 9. Attach appendices containing all commissioning documentation, including logs, minutes, reports, deficiency lists, communications, findings, etc., except that specified to be part of the Commissioning Record.
- C. Recommissioning Manual: Revise the Commissioning Plan documents, checklists, and Functional Test forms as necessary based on accepted recommendations of the final Commissioning Report. Provide step-by-step instructions for recommissioning, blank forms, and cross-references to O&M data needed during recommissioning.

3.08 POST-OCCUPANCY PHASE

- A. Coordinate deferred and seasonal Functional Tests; verify correction of deficiencies.
- B. On-Site Review: 10 months after Substantial Completion conduct on-site review with Owner's staff.
 1. Review the current facility operation and condition of outstanding issues related to the original and seasonal commissioning.
 2. Interview staff to identify problems or concerns they have operating the facility as originally intended.
 3. Make suggestions for improvements and for recording these changes in the O&M manuals.
 4. Identify areas of concern that are still under warranty or are the responsibility of the original construction contractor.
 5. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

END OF SECTION

SECTION 01820**DEMONSTRATION AND TRAINING****PART 1 GENERAL****1.01 SUMMARY**

- A. Demonstration of products and systems to be commissioned and where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. All software-operated systems.
 - 2. HVAC systems and equipment.
 - 3. Plumbing equipment.
 - 4. Electrical systems and equipment.
 - 5. Conveying systems.
 - 6. Landscape irrigation.
 - 7. Items specified in individual product Sections.
- C. Training of Owner personnel in care, cleaning, maintenance, and repair is required for:
 - 1. Roofing, waterproofing, and other weather-exposed or moisture protection products.
 - 2. Finishes, including flooring, wall finishes, ceiling finishes.
 - 3. Fixtures and fittings.
 - 4. Items specified in individual product Sections.

1.02 RELATED REQUIREMENTS

- A. Section 01780 - Closeout Submittals: Operation and maintenance manuals.
- B. Section 01810 - Commissioning: Additional requirements applicable to demonstration and training.
- C. Other Specification Sections: Additional requirements for demonstration and training.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures; except:
 - 1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority.
 - 2. Submit one copy to the Commissioning Authority, not to be returned.
 - 3. Make commissioning submittals on time schedule specified by Commissioning Authority.
 - 4. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of overall Training Plan; submit in editable electronic format, Microsoft Word 2003 preferred.
- B. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
 - 1. Submit to Commissioning Authority for review and inclusion in overall training plan.
 - 2. Submit not less than four weeks prior to start of training.
 - 3. Revise and resubmit until acceptable.
 - 4. Provide an overall schedule showing all training sessions.
 - 5. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm and person conducting training; include qualifications.
 - d. Intended audience, such as job description.
 - e. Objectives of training and suggested methods of ensuring adequate training.
 - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - g. Media to be used, such as slides, hand-outs, etc.
 - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.

- C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
 - 1. Include applicable portion of O&M manuals.
 - 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
 - 3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- D. Training Reports:
 - 1. Identification of each training session, date, time, and duration.
 - 2. Sign-in sheet showing names and job titles of attendees.
 - 3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
 - 4. Include Commissioning Authority's formal acceptance of training session.
- E. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
 - 1. Format: DVD Disc.
 - 2. Label each disc and container with session identification and date.

1.04 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
 - 1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
 - 2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstrations conducted during Functional Testing need not be repeated unless Owner personnel training is specified.
- C. Demonstration may be combined with Owner personnel training if applicable.
- D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.
 - 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Commissioning Authority will prepare the Training Plan based on draft plans submitted.
- B. Conduct training on-site unless otherwise indicated.
- C. Owner will provide classroom and seating at no cost to Contractor.

- D. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
- E. Provide training in minimum two hour segments.
- F. The Commissioning Authority is responsible for determining that the training was satisfactorily completed and will provide approval forms.
- G. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- H. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
 - 1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 - 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 - 3. Typical uses of the O&M manuals.
- I. Product- and System-Specific Training:
 - 1. Review the applicable O&M manuals.
 - 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 - 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 - 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 - 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 - 6. Discuss common troubleshooting problems and solutions.
 - 7. Discuss any peculiarities of equipment installation or operation.
 - 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 - 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 - 10. Review spare parts and tools required to be furnished by Contractor.
 - 11. Review spare parts suppliers and sources and procurement procedures.
- J. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION

Section 02085

VALVE BOXES, METER BOXES, AND METER VAULTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Valve boxes for water service.
- B. Meter boxes for water service.
- C. Meter vaults for water service.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for valve boxes under this Section. Include payment in unit price for Section 02511 - Water Lines.
 - 2. No separate payment will be made for meter boxes under this Section. Include payment in unit price for Section 02512 - Water Tap and Service Line Installation.
 - 3. Payment for each size of meter vaults is on unit price basis per vault. Payment will be made for each vault installed, regardless of depth.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM A 48 - Standard Specification for Gray Iron Castings.
- B. ASTM D 256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- C. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
- D. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.

- E. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- F. ASTM D 2240 - Standard Test Method for Rubber Property-Durometer Hardness.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturers' product data for following items for approval:
 - 1. Each type of valve box and lid.
 - 2. Each type of meter box and cover.
 - 3. Each type of meter vault frame and cover.
- C. Submit design calculations and shop drawings for precast vault elements, sealed by an Engineer registered in State of Texas.
- D. Submit shop drawings for cast-in-place meter vaults for approval if proposed construction varies from Drawings.
- E. Submit manufacturer's certification that plastic meter boxes meet requirements of Paragraph 2.05, Plastic Meter Boxes.

PART 2 PRODUCTS

2.01 VALVE BOXES

- A. Provide approved Type A, cast-iron/ductile-iron, slide-type, valve boxes. Design of valve box shall minimize stresses on valve imposed by loads on box lid.
- B. Cast letter "W" into lid, 1/2 inch in height and raised 3/32 inch, for valves serving potable water lines.
- C. Unless otherwise specified, uncoated cast iron.
- D. Riser Pipe.
 - 1. Provide 6-inch PVC, Class 150, DR 18, riser pipes in accordance with Section 02506 - Polyvinyl Chloride Pipe or

2. 6-inch ductile-iron, thickness Class 51 riser pipes in accordance with Section 02501 – Ductile Iron Pipe and Fittings.
 3. Provide single section of pipe.
- E. Concrete for valve box placement:
1. For locations in new concrete pavement, provide strength and mix design of new pavement.
 2. For other locations, provide concrete for sidewalks conforming to requirements of Section 02751 - Concrete Paving.

2.02 METER BOXES

- A. Provide meter boxes for 5/8-inch through 1-inch meters of the following materials:
1. Non-traffic bearing locations: Cast iron, concrete or plastic.
 2. Traffic bearing locations: Cast iron.
- B. Provide meter boxes for 1 1/2-inch and 2-inch meters of cast iron.
- C. Provide meter box with reading lid. Provide lids with spring-type latching devices. Lids shall contain sufficient metal that meter box can be easily located with metal detector. Cast words "CITY OF HOUSTON" and "WATER METER" into lid with letters of 1/2-inch height and raised 3/32 inch.
- D. Meter box dimensions shall conform to the following approximate dimensions:
1. Length: At top – 15 1/2 inches; at bottom 20 inches
 2. Width: At top – 12 1/2 inches; at bottom 14 3/4 inches
 3. Height: 12 inches
- E. Extensions: Meter box extensions 3 inches and 6 inches in height shall be available from manufacturer as standard item.

2.03 CAST-IRON METER BOXES

- A. Cast-Iron Boxes: Clean and free from sand blow-holes or other defects conforming to requirements of ASTM A 48, Class 30B. Bearing surfaces shall be machined so that covers seat evenly in frames.

- B. Boxes and lids shall have dipped, coal-tar-pitch, varnish finish.
- C. Provide lock-type meter boxes when required by Drawings. Lock mechanisms shall work with ease.

2.04 CONCRETE METER BOXES

- A. Concrete Meter Boxes: Made of Class A concrete, with minimum 4000 psi compressive strength, conforming to requirements of Section 03315 - Concrete for Utility Construction. Construct to dimensions shown on Drawings.
- B. Castings: Free from fractures, large or deep cracks, blisters or surface roughness or any other defects that may affect serviceability.

2.05 PLASTIC METER BOXES

- A. Plastic Meter Boxes: Made of high density polyethylene conforming to the following ASTM standards:

ASTM	REQUIREMENT
D 256	Impact Strength = 1.9 ft.-lb./inch (Izod, Notched)
D 256	Impact Strength = 6.4 ft.-lb./inch (Izod, Un-Notched)
D 638	Tensile Strength (2.0 min.) = 3400 psi
D 648	Deflection Temperature = 170 degrees F
D 2240	Shore D, Hardness, 55-65 Impact Strength, Falling Dart Method, 160 inch-lb.
D 790	Flexural Modulus = 90,000 psi

- B. Meter boxes shall meet the following test requirements:
 1. Static Load: Not less than 2500 pounds using 6-inch disc with direct compression exerted at center of top of meter box with solid plastic lid.
 2. Deflection: Not less than 1000 pounds load required to deflect top edge of meter box 1/8- inch.
- C. Meter box body, without lid, shall weigh approximately 7 pounds.

2.06 METER VAULTS

- A. Meter vaults may be constructed of precast concrete, cast-in-place concrete, or common brick masonry unless a specific type of construction is required by Drawings.
- B. Concrete for Meter Vaults: Class A concrete, conforming to requirements of Section 03315 - Concrete for Utility Construction with minimum compressive strength of 4000 psi at 28 days.
- C. Reinforcing steel for meter vaults: Conform to requirements of Section 03315 Concrete for Utility Construction.
- D. Grates and Covers: Conform to requirements of Section 02084 - Frames, Grates, Rings, and Covers.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Obtain approval from Project Manager for location of meter vault.
- B. Verify lines and grade are correct.
- C. Verify compacted subgrade will support loads imposed by vaults.

3.02 VALVE BOXES

- A. Install riser pipe with suitable length for depth of cover indicated on Drawings or to accommodate actual finish grade.
 - 1. Install with bell on top of valve
 - 2. Place riser pipe in plumb, vertical position
- B. Install valve box and riser piping plumbed in a vertical position. Provide 6-inches telescoping freeboard space between riser pipe top butt end, and interior contact flange of valve box, for vertical movement damping. End of pipe resting on valve shall be notched out sufficiently to provide a snug fit around the valve bonnet and to center valve inside of pipe.
- C. Set, align, and adjust valve box so that lid is level with final grade.
- D. Paint covers of new valve boxes in fluorescent orange when installed. After completion and acceptance by City, repaint covers black.

3.03 METER BOXES

- A. Install cast iron or plastic boxes in accordance with manufacturer's instructions.
- B. Construct concrete meter boxes to dimensions shown on Drawings.
- C. Adjust top of meter boxes to conform to cover elevations specified in Paragraph 3.05, Frame and Cover for Meter Vaults.
- D. Do not locate under paved areas unless approved by Project Manager. Use approved traffic-type box with cast iron lid when meter must be located in paved areas.

3.04 METER VAULTS

- A. Construct concrete meter vaults to dimensions shown on Drawings. Do not cast in presence of water. Make bottom uniform. Verify lines and grades are correct and compacted subgrade will support loads imposed by vaults.
- B. Precast Meter Vaults:
 - 1. Install precast vaults in accordance with manufacturer's recommendations. Set level on a minimum 3-inch-thick bed of sand conforming to requirements of Section 02320 - Utility Backfill Materials.
 - 2. Seal lifting holes with cement-sand mortar or non-shrink grout.
- C. Meter Vault Floor Slab:
 - 1. Construct floor slabs of 6-inch-thick reinforced concrete. Slope floor 1/4 inch per foot toward sump. Make sump 12 inches in diameter, or 12 inches square, and 4 inches deep, unless other dimensions are required by Drawings. Install dowels at maximum of 18 inches, center-to-center for keying walls to floor slab.
 - 2. Precast floor slab elements may be used for precast vault construction
- D. Cast-in-Place Meter Vault Walls:
 - 1. Key walls to floor slab and form to dimensions shown on Drawings. Minimum wall thickness shall be 4 inches.
 - 2. Cast walls monolithically. One cold joint will be allowed when vault depth exceeds 12 feet.
 - 3. Set frame for cover in concrete

3.05 FRAME AND COVER FOR METER VAULTS

- A. Set cast iron frame in a mortar bed and adjust elevation of cover as follows:
 - 1. In unpaved areas, set top of meter box or meter vault cover 2 to 3 inches above natural grade
 - 2. In paved areas, set top of meter box or meter vault cover flush with adjacent concrete but no higher than 1/2-inch

3.06 BACKFILL

- A. Provide bank run sand in accordance with Section 02320 - Utility Backfill Materials and backfill and compact in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. In unpaved areas, slope backfill around meter boxes and vaults to provide a uniform slope 1-to-5 slope from top to natural grade.
- C. In paved areas, slope concrete down from meter box or vault to meet adjacent paved area.

END OF SECTION

Section 02221

REMOVING EXISTING PAVEMENTS, STRUCTURES, WOOD, AND DEMOLITION DEBRIS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removing concrete paving, asphaltic concrete pavement, brick pavement and base courses.
- B. Removing concrete curbs, concrete curbs and gutters, sidewalks and driveways.
- C. Removing pipe culverts, sewers, and sewer leads.
- D. Removing waterlines and water services lines including asbestos cement pipe per OSHA guidelines.
- E. Removing existing inlets and manholes.
- F. Removing and disposing of pre-stressed concrete beams and drill shafts.
- G. Removing miscellaneous structures of concrete or masonry.
- H. Removing existing bridge.
- I. Removing existing wood and demolition debris.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for removing and disposing of asphaltic surfacing with or without base, regardless of thickness encountered, is on square yard basis measured between lips of gutters.
 - 2. Payment for removing and disposing of reinforced concrete pavement, with or without asphalt overlay, regardless of its thickness, is on square yard basis measured from back-to-back of curbs. Payment includes concrete pavement, esplanade curbs, curbs and gutters, and paving headers.
 - 3. Payment for removing and disposing of cement stabilized shell base course, with or without asphaltic surfacing, is on square yard basis.
 - 4. Payment for removing and disposing of concrete sidewalks and driveways is on square yard basis.

5. Payment for removing asphaltic pavement surface by milling shall be in accordance with Section 2960.
 6. Payment for removing and disposing of miscellaneous concrete and masonry is on cubic yard basis of structure in place.
 7. Payment for removing and disposing of pipe culverts, sewers, and sewer leads, is on linear foot basis for each diameter and each material type of pipe removed.
 8. Payment for removing and disposing of waterlines and water service lines including asbestos cement pipe is on linear foot basis for each diameter pipe and each material type of pipe removed.
 9. Payment for removing and disposing of existing inlets is on unit price basis for each inlet removed.
 10. Payment for removing and disposing of prestressed concrete piles and drill shafts is on linear foot basis.
 11. Payment for removing and disposing of existing bridge, including piles and abutments to minimum of 4 feet below ground level, is on a lump sum basis.
 12. Payment for removing and disposing of existing manholes is on unit price basis for each manhole removed.
 13. Payment for removing and disposing of miscellaneous wood and demolition debris is on cubic yard basis.
 14. No payment for saw cutting of pavement, curbs, or curbs and gutters will be made under this section. Include cost of such work in unit prices for items listed in bid form requiring saw cutting.
 15. No payment will be made for work outside maximum payment limits indicated on Drawings, or for pavements or structures removed for Contractor's convenience.
 - a. For utility installations: Match actual pavement replaced but no greater than maximum pavement replacement limits shown on Drawings. Limits of measurement will be as shown on Street Cut Pavement Replacement Rules.
 16. Refer to Section 01270 - Measurement and Payment for unit price procedures
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.1.03 REGULATORY REQUIREMENTS
- A. Conform to applicable codes for disposal of debris.

- B. Coordinate removal work with utility companies.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.01 PREPARATION

- A. Obtain advance approval from Project Manager for dimensions and limits of removal work.
- B. Identify known utilities below grade. Stake and flag locations.

3.02 PROTECTION

- A. Protect following from damage or displacement:
 1. Adjacent public and private property.
 2. Trees, plants, and other landscape features designated to remain.
 3. Utilities designated to remain.
 4. Pavement and utility structures designated to remain.
 5. Bench marks, monuments, and existing structures designated to remain.

3.03 REMOVALS

- A. Remove pavements and structures by methods that will not damage underground utilities. Do not use drop hammer near existing underground utilities.
- B. Minimize amount of earth loaded during removal operations.
- C. Where existing pavement is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut to minimum depth of 2 inches.
- D. When street and driveway saw cut location is greater than one-half of pavement lane width, remove pavement for full lane width or to nearest longitudinal joint as directed by Project Manager.
- E. Remove sidewalks and curbs to nearest existing dummy, expansion, or construction joint.
- F. Where existing end of pipe culvert or end of sewer is to remain, install 8-inch-thick masonry plug in pipe end prior to backfill in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.

3.04 BACKFILL

- A. Backfill of removal areas shall be in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.

3.05 DISPOSAL

- A. Inlet frames, grates, and plates; and manhole frames and covers, may remain City property. Disposal shall be in accordance with requirements of Section 01576 - Waste Material Disposal.
- B. Remove from site, debris resulting from work under this section in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02233

CLEARING AND GRUBBING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Removing surface debris and rubbish.
- B. Clearing site of plant life and grass.
- C. Removing trees and shrubs.
- D. Removing root system of trees and shrubs.
- E. Fence removal.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for clearing and grubbing is on per acre basis.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for disposal of debris.
- B. Coordinate clearing work with utility companies.

PART 2 P R O D U C T S - Not Used

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that existing plant life and features designated to remain are identified and tagged.

3.02 PROTECTION

- A. Protect following from damage or displacement:
 - 1. Living trees located 3 feet or more outside of intersection of side slopes and original ground line.
 - 2. Plants other than trees and landscape features designated to remain.
 - 3. Utilities designated to remain.
 - 4. Bench marks, monuments, and existing structures designated to remain.

3.03 CLEARING

- A. Remove stumps, main root ball, and root system to:
 - 1. Depth of 24 inches below finished subgrade elevation in area bounded by lines two feet behind back of curbs.
 - 2. Depth of 24 inches below finished surface of required cross section for other areas.
- B. Clear undergrowth and deadwood without disturbing subsoil.
- C. Remove vegetation from top soil scheduled for reuse.

3.04 REMOVAL

- A. Remove debris, rubbish, and extracted plant material life from site in accordance with requirements of Section 01576 - Waste Material Disposal.
- B. Remove on site fences. Materials generated from removal of fences become property of Contractor. Properly dispose of in accordance with applicable local, state and federal laws.

END OF SECTION

Section 02260

TRENCH SAFETY SYSTEM

PART GENERAL

1.01 SECTION INCLUDES

- A. Trench safety system for the construction of trench excavations.
- B. Trench safety system for structural excavations which fall under provisions of State and Federal trench safety laws.
- C. This Standard Specification Section replaces previously published Section 01561-Trench Safety System.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Measurement for trench safety systems used on trench excavations is on a linear foot basis measured along the centerline of the trench, including manholes and other line structures.
 - 2. No payment will be made for trench safety systems for structural excavations under this section. Include payment for trench safety system in applicable structure installation sections.
 - 3. Refer to Section 01270 - Measurement and payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 DEFINITIONS

- A. A trench shall be defined as a narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet.
- B. The trench safety system requirements will apply to larger open excavations if the erection of structures or other installations limits the space between the excavation slope and these installation to dimensions equivalent of a trench as defined.

- C. Trench Safety Systems include but are not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.

1.04 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit a safety program specifically for the construction of trench excavation. Design the trench safety program to be in accordance with OSHA 29CFR standards governing the presence and activities of individuals working in and around trench excavations.
- C. Construction and shop drawings containing deviations from OSHA standards or special designs shall be sealed by a licensed Engineer retained and paid by Contractor.
- D. Review of the safety program by the City Engineer will only be in regard to compliance with this specification and will not constitute approval by the City Engineer nor relieve Contractor of obligations under State and Federal trench safety laws.

1.05 REGULATORY REQUIREMENTS

- A. Install and maintain trench safety systems in accordance with the detail specifications set out in the provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in the Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989. The sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-652.
- B. A reproduction of the OSHA standards included in "Subpart P - Excavations" from the Federal Register Vol. 54, No. 209 is available upon request to Contractors bidding on City projects. The City assumes no responsibility for the accuracy of the reproduction. The Contractor is responsible for obtaining a copy of this section of the Federal Register.
- C. Legislation that has been enacted by the Texas Legislature with regard to Trench Safety Systems, is hereby incorporated, by reference, into these specifications. Refer to Texas Health and Safety Code Ann., §756.021 (Vernon 1991).
- D. Reference materials, if developed for a specific project, will be issued with the Bid Documents, including the following:
 - 1. Document 00820 - Trench Safety Geotechnical Information: Geotechnical information obtained for use in design of the trench safety system.
 - 2. Document 00821 - Special Shoring Requirements.

1.06 INDEMNIFICATION

- A. Contractor shall indemnify and hold harmless the City, its employees and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgements or claims by anyone for injury or death of persons resulting from the collapse or failure of trenches constructed under this Contract.
- B. Contractor acknowledges and agrees that this indemnity provision provides indemnity for the City in case the City is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failures to issue stop work orders, and the hiring of the Contractor.

PART PRODUCTS - Not Used

PART EXECUTION

3.01 INSTALLATION

- A. Install and maintain trench safety systems in accordance with provisions of OSHA 29CFR.
- B. Install specially designed trench safety systems in accordance with the Contractor's trench excavation safety program for the locations and conditions identified in the program.
- C. A competent person, as identified in the Contractor's Trench Safety Program, shall verify that trench boxes and other premanufactured systems are certified for the actual installation conditions.

3.02 INSPECTION

- A. Contractor, or Contractor's independently retained consultant, shall make daily inspections of the trench safety systems to ensure that the installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.
- B. If evidence of possible cave-ins or slides is apparent, Contractor shall immediately stop work in the trench and move personnel to safe locations until the necessary precautions have been taken by Contractor to safeguard personnel entering the trench.
- C. Maintain a permanent record of daily inspections.

3.03 FIELD QUALITY CONTROL

- A. Contractor shall verify specific applicability of the selected or specially designed trench safety systems to each field condition encountered on the project.

END OF SECTION

Section 02315

ROADWAY EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation and compaction of materials for roadways.
- B. Excavation and compaction of materials for roadside ditches.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for roadway excavation, with or without subgrade, is on cubic yard basis. Unless specified otherwise under the borrow (off-site) material or embankment fill work item, measurement for payment shall be based on the cut quantity shown on the drawing.
 - 2. No payment will be made for material excavated under the following conditions:
 - a. More than 2 feet outside of vertical planes behind back of curbs
 - b. For portion within limits of trench for utilities 24-inch and greater constructed by open-cut methods
 - c. As indicated otherwise on Drawings.
 - 3. Measurement for the bid item "Regrade Ditches" is on a linear foot basis. No separate payment will be made for reshaping and regrading roadway ditch shoulder slope and side slope adjacent to installed temporary pavement upon removal of temporary pavement.
 - 4. If specified, off-site borrow material including placement and compaction will be paid by final in-place quantity on cubic yard basis.
 - 5. If specified and shown on the drawing, embankment fill including placement and compaction will be paid by final in-place quantity on cubic yard basis.
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44 ft-lbf/ft³).
- B. ASTM D 2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- C. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).D. ASTM D 3017 - Standard Test Method for Water content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- E. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Provide topsoil conforming to requirements of Section 02911 - Topsoil.
- B. Provide backfill which is excavated material, graded free of roots, lumps greater than 6 inches, rocks larger than 3 inches, organic material, and debris.
- C. Provide structural backfill which is select material meeting following requirements:
 - 1. Plasticity index: not less than 12 nor more than 20.
 - 2. Maximum liquid limit: 45

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, and datum. Coordinate with Section 01725 - Field Surveying.
- B. Identify and flag surface and aerial utilities.
- C. Notify utility companies to remove or relocate utilities.
- D. Identify, stake, and flag known utility locations below grade. Make temporary or permanent relocation of underground pipes, ducts, or utilities where indicated on Drawings.
- E. Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Project Manager and obtain instructions before proceeding in such areas.

- F. Obtain approval of top soil quality before excavating and stockpiling.

3.02 PROTECTION

- A. Protect following from damage or displacement:
 - 1. Trees, shrubs, lawns, existing structures, and other features outside of grading limits.
 - 2. Utilities either above or below grade, which are to remain.

3.03 TOPSOIL REMOVAL

- A. Strip off topsoil from area to be excavated to minimum depth of 6 inches, unless indicated otherwise on Drawings.
- B. Stockpile topsoil in designated location for reuse. Stockpile topsoil to depth not exceeding 8 feet. Cover to protect from erosion.

3.04 SOIL EXCAVATION

- A. Excavate to lines and grades shown on Drawings.
- B. Remove unsuitable material not meeting specifications. Backfill with embankment materials and compact to requirements of Section 02330 - Embankment.
- C. Record location and plug and fill inactive water and oil wells. Conform to Texas Department of Health, Texas Natural Resource Conservation Commission, and Texas Railroad Commission requirements. Notify Project Manager prior to plugging wells.
- D. At intersections, grade back at minimum slope of one inch per foot. Produce smooth riding junction with intersecting street. Maintain proper drainage.
- E. When area is inadvertently over excavated, fill area in accordance with requirements of Section 02330 - Embankment at no additional cost to City.
- F. Remove material not qualified for use and excess soil not being reused from site in accordance with requirements of Section 01576 - Waste Material Disposal.

3.05 COMPACTION

- A. Maintain optimum moisture content of subgrade to attain required density.
- B. Compact to following minimum densities at moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on Drawings:

1. Areas under future paving and shoulders: Minimum density of 95 percent of maximum dry density.
2. Other areas: Minimum density of 90 percent of maximum dry density.

3.06 TOLERANCES

- A. Top of Compacted Surface: Plus or minus 1/2 inch in cross section, or in 16-foot length.

3.07 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Test and analysis of soil materials will be performed in accordance with ASTM D 4318, ASTM D 2216, and ASTM D 698.
- C. Compaction testing will be performed in accordance with ASTM D 698 or ASTM D 2922 and ASTM D 3017.
- D. A minimum of three tests will be taken for each 1000 linear feet per lane of roadway.
- E. When tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at no additional cost to City.

3.08 PROTECTION

- A. Prevent erosion at all times. Maintain ditches and cut temporary swales to allow natural drainage in order to avoid damage to roadway. Do not allow water to pond.
- B. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.
- C. Maintain excavation and embankment areas until start of subsequent work. Repair and recompact slides, washouts, settlements, or areas with loss of density.

END OF SECTION

Section 02316

EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation, backfilling, and compaction of backfill for structures.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for structural excavation and backfill under this Section. Include payment in unit price or lump sum for construction of structures.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

- A. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- B. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement shall be considered suitable, unless otherwise indicated.
- C. Select Material: Material as defined in Section 02320 - Utility Backfill Materials.

- D. Backfill: Material meeting specified quality requirements, placed and compacted under controlled conditions around structures.
- E. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.
- F. Foundation Base: For foundation base material, use crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.
- G. Foundation Subgrade: Foundation subgrade is surface of natural soil which has been excavated and prepared to support foundation base or foundation backfill, where needed.
- H. Ground Water Control Systems: Installations external to excavation such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.
- I. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from excavation. Remove rain water and surface water which accidentally enters excavation as part of excavation drainage.
- J. Excavation Drainage: Removal of surface and seepage water in excavation by sump pumping and using French drains surrounding foundation to intercept water.
- K. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below foundation as shown on Drawings, and backfilled with foundation backfill material.
- L. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins.

1.04 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600kN-m/m³)).
- B. ASTM D 1556 - Standard Test Method for Density of Soil in Place by Sand-Cone Method.
- C. ASTM D 2922 - Standard Test Methods for Density of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

- D. ASTM D 3017 - Standard Test Method for Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths).
- E. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- F. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.
- G. TxDOT Tex-110-E - Particle Size Analysis of Soils.
- H. Federal Regulations, 29 CFR, Part 1926, Standards - Excavation, Occupational Safety and Health Administration (OSHA).

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit work plan for excavation and backfill for each structure with complete written description which identifies details of proposed method of construction and sequence of operations for construction relative to excavation and backfill activities. Use descriptions, with supporting illustrations, sufficiently detailed to demonstrate to Project Manager that procedures meet requirements of Specifications and Drawings.
- C. Submit excavation safety system plan.
 - 1. Submit excavation safety system plan in accordance with applicable OSHA requirements for excavations.
 - 2. Submit excavation safety system plan in accordance with requirements of Section 02260 - Trench Safety System, for excavations that fall under State and Federal trench safety laws.
- D. Submit ground and surface water control plan in accordance with requirements in this Section and Section 01578 - Control of Ground Water and Surface Water.
- E. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.
- F. Submit project record documents under provisions of Section 01785 - Project Record Documents. Record location of utilities, as installed, referenced to survey benchmarks. Include location of utilities encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.06 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.
- B. Perform embedment and backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Perform excavation with equipment suitable for achieving requirements of this Specification.
- B. Use equipment which will produce degree of compaction specified. Compact backfill within 3 feet of walls with hand operated equipment. Do not use equipment weighing more than 10,000 pounds closer to walls than a horizontal distance equal to depth of fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

2.02 MATERIAL CLASSIFICATIONS

- A. Use backfill materials conforming to classifications and product descriptions of Section 02320 - Utility Backfill Materials. Use classification or product description for backfill applications as shown on Drawings and as specified.

PART 3 EXECUTION

3.01 PREPARATION

- A. Conduct an inspection to determine condition of existing structures and other permanent installations.
- B. Set up necessary street detours and barricades in preparation for excavation if construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning devices at all times for streets and intersections where work is in progress, or where affected by Work, and is considered hazardous to traffic movements.
- C. Perform work in accordance with OSHA standards. Employ an excavation safety system as specified in Section 02260 - Trench Safety Systems.

- D. Remove existing pavements and structures, including sidewalks and driveways, in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.
- E. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01578 - Control of Ground Water and Surface Water.

3.02 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.
- D. Prevent erosion of excavations and backfill. Do not allow water to pond in excavations.
- E. Maintain excavation and backfill areas until start of subsequent work. Repair and recompact slides, washouts, settlements, or areas with loss of density at no additional cost to City.

3.03 EXCAVATION

- A. Perform excavation work so that underground structure can be installed to depths and alignments shown on Drawings. Use caution during excavation work to avoid disturbing surrounding ground and existing facilities and improvements. Keep excavation to absolute minimum necessary. No additional payment will be made for excess excavation not authorized by Project Manager.
- B. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding in such areas.
- C. Immediately notify agency or company owning any line which is damaged, broken or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.
- D. Avoid settlement of surrounding soil due to equipment operations, excavation procedures, vibration, dewatering, or other construction methods.
- E. Provide surface drainage during construction to protect work and to avoid nuisance to adjoining property. Where required, provide proper dewatering and piezometric pressure control during construction.

- F. Conduct hauling operations so that trucks and other vehicles do not create dirt nuisance in streets. Verify that truck beds are sufficiently tight and loaded in such a manner such that objectionable materials will not spill onto streets. Promptly clear away any dirt, mud, or other materials that spill onto streets or are deposited onto streets by vehicle tires.
- G. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed, replace those which are damaged or destroyed by Work.
- H. Provide sheeting, shoring, and bracing where required to safely complete Work, to prevent excavation from extending beyond limits indicated on Drawings, and to protect Work and adjacent structures or improvements. Use sheeting, shoring, and bracing to protect workmen and public conforming to requirements of Section 02260 - Trench Safety Systems.
- I. Prevent voids from forming outside of sheeting. Immediately fill voids with grout, cement stabilized sand, or other material approved by Project Manager and compact to 95 percent standard density.
- J. After completion of structure, remove sheeting, shoring, and bracing unless shown on Drawings to remain in place or directed by Project Manager in writing that such temporary structures may remain. Remove sheeting, shoring and bracing in such a manner as to maintain safety during backfilling operations and to prevent damage to Work and adjacent structures or improvements.
- K. Immediately fill and compact voids left or caused by removal of sheeting with cement stabilized sand or other material approved by Project Manager and compact to 95 percent standard density.

3.04 HANDLING EXCAVATED MATERIALS

- A. Classify excavated materials. Place material which is suitable for use as backfill in orderly piles at sufficient distance from excavation to prevent slides or cave-ins.
- B. Provide additional backfill material in accordance with requirements of Section 02319 - Borrow, if adequate quantities of suitable material are not available from excavation and trenching operations at site.

3.05 DEWATERING

- A. Provide ground water control per Section 01578 - Control of Ground Water and Surface Water.
- B. Keep ground water surface elevation minimum of 2 feet below bottom of foundation base.

- C. Maintain ground water control as directed by Section 01578 - Control of Ground Water and Surface Water and until structure is sufficiently complete to provide required weight to resist hydrostatic uplift with minimum safety factor of 1.2.

3.06 FOUNDATION EXCAVATION

- A. Notify Project Manager at least 48 hours prior to planned completion of foundation excavations. Do not place foundation base until excavation is accepted by Project Manager.
- B. Excavate to elevations shown on Drawings, as needed to provide space for foundation base, forming level undisturbed surface, free of mud or soft material. Remove pockets of soft or otherwise unstable soils and replace with foundation backfill material or material as directed by Project Manager. Prior to placing material over it, recompact subgrade where indicated on Drawings, scarifying as needed, to 95 percent of maximum Standard Dry Density according to ASTM D 698. If specified level of compaction cannot be achieved, moisture condition subgrade and recompact until 95 percent is achieved, over-excavate to provide minimum layer of 24 inches of foundation backfill material, or other means acceptable to Project Manager.
- C. Fill unauthorized excessive excavation with foundation backfill material or other material as directed by Project Manager.
- D. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition. Keep excavations free of standing water and completely free of water during concrete placement.
- E. Remove soils which become unsuitable due to inadequate dewatering or other causes, after initial excavation to required subgrade, and replace with foundation backfill material, as directed by Project Manager, at no additional cost to City.
- F. Place foundation base, or foundation backfill material where needed, over subgrade on same day that excavation is completed to final grade. Where base of excavations are left open for longer periods, protect them with seal slab or cement-stabilized sand.
- G. Use filter fabric as specified in Section 02621 - Geotextile to separate crushed aggregate, and other free draining Class I materials from native soils or select material backfill. Overlap fabric minimum of 12 inches beyond where another material stops contact with soil.
- H. Place crushed aggregate, and other Class I materials, in uniform layers of 8-inch maximum thickness. Perform compaction by means of at least two passes of vibratory compactor.

3.07 FOUNDATION BASE.

- A. Place foundation base after subgrade is properly prepared, including placement of foundation backfill where needed. Use foundation base consisting of 12-inch layer of crushed stone aggregate or cement stabilized sand. Alternately, seal slab with minimum thickness of 4 inches may be placed. Extend foundation base minimum of 12 inches beyond edge of structure foundation, unless shown otherwise on Drawings.
- B. Where foundation base and foundation backfill are of same material, both can be placed in one operation.

3.08 BACKFILL

- A. Complete backfill to surface of natural ground or to lines and grades shown on Drawings. Remove forms, lumber, trash and debris from structures. Deposit backfill in uniform layers and compact each layer as specified.
 - 1. Unless otherwise shown on Drawings, for structures under pavement or within one foot back of curb, use cement stabilized sand up to the top of the proposed structure. Use suitable on-site material (random backfill) up to 12 inches below pavement base or subgrade. Place minimum of 12 inches of select backfill below pavement base or subgrade.
 - 2. Unless otherwise shown on Drawings, for structures not under pavement, use random backfill of suitable material up to the surface.
- B. Do not place backfill against concrete walls or similar structures until laboratory test breaks indicate that concrete has reached minimum of 85 percent of specified compressive strength. Where walls are supported by slabs or intermediate walls, do not begin backfill operations until slab or intermediate walls have been placed and concrete has attained sufficient strength.
- C. Remove concrete forms before starting backfill and remove shoring and bracing as work progresses.
- D. Maintain backfill material at no less than 2 percent below nor more than 2 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698 below paved areas. Compact fill to at least 90 percent around structures below unpaved areas.
- E. Where backfill is placed against sloped excavation surface, run compaction equipment across boundary of cut slope and backfill to form compacted slope surface for placement of next layer of backfill.
- F. Place backfill using cement stabilized sand in accordance with Section 02321 - Cement Stabilized Sand.

3.09 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Tests will be performed initially on minimum of one different sample of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity.
- C. In-place density tests of compacted subgrade and backfill will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at following frequencies and conditions:
 - 1. Minimum of one test for every 50 to 100 cubic yards of compacted backfill material as directed by Project Manager.
 - 2. A minimum of three density tests for each full work shift.
 - 3. Density tests will be performed in all placement areas.
 - 4. Number of tests will be increased when inspection determines that soil types or moisture contents are not uniform or when compacting effort is variable and not considered sufficient to attain uniform density.
 - 5. Identify elevation of test with respect to natural ground.
 - 6. Record approximate depth of lift tested.
- D. At least one test for moisture-density relationships will be initially performed for each type of backfill material in accordance with ASTM D 698. Perform additional moisture-density relationship test once a month or whenever there is noticeable change in material gradation or plasticity.
- E. When tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at Contractor's expense.

3.10 DISPOSAL OF EXCESS MATERIAL

Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02317

EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

- 1. No additional payment will be made for trench excavation, embedment and backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.
- 2. When Project Manager directs Contractor to over excavate trench bottom, Contractor will be paid by unit price bid per linear foot under bid item - 6" Over Excavation of Trench Bottom.
 - a. No payment will be paid if Project Manager does not direct Contractor to over excavate trench bottom.
 - b. No over excavation will be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01578 - Control of Ground Water and Surface Water.
- 3. No additional payment will be made for performing Critical Location exploratory excavation. Include cost for unit price for work requiring critical location.
- 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price

1.03 DEFINITIONS

- A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Drawings, or foundation backfill material placed and compacted in over-excavations.

- B. Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
- C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.
- D. Initial Backfill: Portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
- E. Pipe Embedment: Portion of trench backfill that consists of bedding, haunching and initial backfill.
- F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.
- G. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.
- I. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.
- J. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.

- K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.
- L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D 2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.
- M. Trench Conditions are defined with regard to stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
 2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.
 - a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
 - b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.
 3. Unstable Trench: Unstable trench conditions exist in pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.
- N. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.
- O. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.
- P. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings, and backfilled with foundation backfill material.

- Q. Foundation Backfill Materials: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.
- R. Trench Safety Systems include both protective systems and shoring systems as defined in Section 02260 - Trench Safety Systems.
- S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.
- T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.
- U. Special Shoring: Shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements, for locations identified on Drawings.

1.04 REFERENCES

- A. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
- B. ASTM D 558 - Standard Test Methods for Moisture-Density Relations of Soil Cement Mixtures.
- C. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft).
- D. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- E. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- F. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes.
- G. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- H. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

- I. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- J. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.
- K. TxDOT Tex-110-E - Particle Size Analysis of Soils.
- L. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).
- M. ASTM C76- Standard Specification for Reinforced Concrete Culverts, Storm Drain, and Sewer Pipe.

1.05 SCHEDULING

- A. Schedule work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit planned typical method of excavation, backfill placement and compaction including:
 - 1. Trench widths.
 - 2. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction.
 - 3. Procedures for assuring compaction against undisturbed soil when pre-manufactured trench safety systems are proposed.
- C. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.
- D. Submit trench excavation safety program in accordance with requirements of Section 02260 - Trench Safety System. Include designs for special shoring meeting requirements defined in Paragraph 1.08, Special Shoring Design Requirements contained herein.
- E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.

- F. Submit 11 inch by 17 inch or 12 inch by 18 inch copy of Drawing with plotted utility or obstruction location titled "Critical Location Report" to Project Manager.

1.07 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.
- B. Perform backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

1.08 SPECIAL SHORING DESIGN REQUIREMENTS

- A. Have special shoring designed or selected by Contractor's Professional Engineer to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a premanufactured system selected by Contractor's Professional Engineer to meet project site requirements based on manufacturer's standard design.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.
- B. Use only hand-operated tamping equipment until minimum cover of 12 inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.
- C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.
- D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.08, Special Shoring Design Requirements.

2.02 MATERIAL CLASSIFICATIONS

- A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials.

- B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315 - Concrete for Utility Construction.
- C. Geotextile (Filter Fabric): Conform to requirements of Section 02621- Geotextile.
- D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.
- E. Timber Shoring Left in Place: Untreated oak.

PART 3 EXECUTION

3.01 STANDARD PRACTICE

- A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.
- B. Install rigid pipe to conform to standard practice described in ASTM C 12 or C76 as applicable, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.
- C. Classification of material will be determined by Project Manager.

3.02 PREPARATION

- A. Establish traffic control to conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by Work, and are considered hazardous to traffic movements.
- B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02260 - Trench Safety Systems.
- C. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.
- D. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02221 - Removing Existing Pavements and Structures, as applicable.
- E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01578 - Control of Ground Water and Surface Water. Provide stable trench to allow installation in accordance with Specifications.

- F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 - Field Surveying.

3.03 CRITICAL LOCATION INVESTIGATION

- A. Horizontal and vertical location of various underground lines shown on Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations. At Critical Locations shown on Drawings, field verify horizontal and vertical locations of such lines within zone 2 feet vertically and 4 feet horizontally of proposed work.
 - 1. Verify location of existing utilities minimum of 7 working days in advance of pipe laying activities based on daily pipe laying rate. Use extreme caution and care when uncovering these lines.
 - 2. Notify Project Manager in writing immediately upon identification of obstruction. In event of failure to identify obstruction in minimum of 7 days, Contractor will not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until 7 days has passed from time Project Manager is notified of obstruction.
- B. Notify involved utility companies of date and time that investigation excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Project Manager with 48 hours notice prior to field excavation or related work.
- C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot on 12 inch by 18 inch copy of Drawings. For large diameter water lines, submit to Project Manager for approval, horizontal and vertical alignment dimensions for connections to existing lines, tied into project baseline, signed and sealed by R.P.L.S.

3.04 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.

- D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, re-compact, and pave those areas at no additional cost to City.

3.05 EXCAVATION

- A. Except as otherwise specified or shown on Drawings, install underground utilities in open cut trenches with vertical sides.
- B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.
- C. Determine trench excavation widths using following schedule as related to pipe outside diameter (O.D.).

Nominal Pipe Size, Inches	Minimum Trench Width, Inches
Less than 18	O.D. + 18
18 to 30	O.D. + 24
36 to 42	O.D. + 36
Greater than 42	O.D. + 48

- D. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.
- E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding.
- F. Shoring of Trench Walls.
 - 1. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.
 - 2. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.
 - 3. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by Project

Manager. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.

4. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
 5. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.
- G. Use of Trench Shields. When trench shield (trench box) is used as worker safety device, the following requirements apply:
1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.
 2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re-compact after shield is moved if soil is disturbed.
 3. When required, place, spread, and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.
 4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.
 5. Conform to applicable Government regulations.
- H. Voids under paving area outside shield caused by Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate supports.
- I. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.
- J. Coordinate excavation within 15 feet of pipeline with company's representative. Support pipeline with methods agreed to by pipeline company's representative. Use small, rubber-tired excavator, such as backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket

without teeth. Excavate by hand within 1 foot of Pipeline Company's line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by Pipeline Company's representative.

- K. When, during excavation to uncover pipeline company's pipelines, screwed collar or an oxy-acetylene weld is exposed, immediately notify Project Manager. Provide supports for collar or welds. Discuss with Pipeline Company's representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.

3.06 HANDLING EXCAVATED MATERIALS

- A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section 02320 - Utility Backfill Materials. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.
- B. When required, provide additional backfill material conforming to requirements of Section 02320 - Utility Backfill Materials.
- C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect backfill material to be used on site. Maintain site conditions in accordance with Section 01504 - Temporary Facilities and Controls. Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

3.07 TRENCH FOUNDATION

- A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.
- B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional 6 inches with approval by Project Manager. Place non-woven geotextile fabric and then compact 12 inches of crushed stone in one lift on top of fabric. Compact crushed stone with four passes of vibratory-type compaction equipment.
- C. Perform over excavation, if directed by Project Manager, in accordance with Paragraph 3.08B above. Removal of unstable or unsuitable material may be required if approved by Project Manager;
 - 1. Even though Contractor has not determined material to be unsuitable, or
 - 2. If unstable trench bottom is encountered and an adequate ground water control system is installed and operating according to Section 01578 - Control of Ground Water and Surface Water.

- D. Place trench dams in Class I foundations in line segments longer than 100 feet between manholes and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.08 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

- A. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.
- B. Place embedment including bedding, haunching, and initial backfill as shown on Drawings.
- C. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.
- D. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.
- E. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.
- F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.
- G. Place haunching material manually around pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sand bags or other suitable means.
- H. Place electrical conduit, if used, directly on foundation without bedding.
- I. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.
- J. For water lines construction embedment, use bank run sand, concrete sand, gem sand, pea gravel, or crushed limestone as specified in Section 02320 - Utility Backfill Material. Adhere to the following subparagraph numbers 1 and 2.

- 1. Class I, II and III Embedment Materials:

- a. Maximum 6 inches compacted lift thickness.
 - b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be within -3 percent to +5 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Project Manager.
2. Cement Stabilized Sand (where required for special installations):
 - a. Maximum 6 inches compacted thickness.
 - b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be on dry side of optimum as determined according to ASTM D 698 but sufficient for effective hydration.
- K. For Sanitary Sewers adhere to subparagraph number 1 and 2. For Storm Sewers provide cement stabilized sand per paragraph 2. This provision does not apply to Storm Sewers constructed of HDPE pipe installed under pavement.
1. Class I Embedment Materials.
 - a. Maximum 6-inches compacted lift thickness.
 - b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.
 - c. Moisture content as determined by Contractor for effective compaction without softening soil of trench bottom, foundation or trench walls.
 2. Class II Embedment and Cement Stabilized Sand.
 - a. Maximum 6-inches compacted thickness.
 - b. Compaction by methods determined by Contractor to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.
 - c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized

sands on dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.

- L. For Storm Sewers constructed of HDPE pipe and installed under pavement provide flowable fill pipe embedment as specified in Section 02322 Flowable Fill.
- M.. Place trench dams in Class I embedment in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.09 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.
- B. For water lines, backfill in trench zone, including auger pits, intermediate and site pits, with bank run sand, select fill, or random backfill material as specified in Section 02320 - Utility Backfill materials.
- C. For sewer pipes (Storm and Sanitary), use backfill materials described by trench limits. For "trench zone backfill" under pavement and to within one foot back of curb, use cement stabilized sand for pipes of nominal sizes 36 inches in diameter and smaller to level 12 inches below the pavement. For sewer pipes 42 inches in diameter and larger, under pavement or natural ground, in satisfactory soil conditions, backfill from 12 inches above top of pipe to 12 inches below pavement with suitable on-site material or select backfill. For sewer pipes 42 inches in diameter and larger, under pavement or natural ground, in unsatisfactory soil conditions, backfill from 12 inches above top of pipe to 12 inches below pavement with suitable on-site material or select backfill. Use select backfill for rigid pavements or flexible base material for asphalt pavements for 12- inch backfill directly under pavement. For backfill materials reference Section 02320 - Utility Backfill Materials. This provision does not apply where a Storm Sewer is constructed of HDPE pipe.
- D. For Storm Sewers constructed of HDPE pipe and installed under pavement provide flowable fill as specified in Section 02322 Flowable Fill. For Storm Sewers constructed of HDPE pipe and not installed under pavement provide cement stabilized sand.
- E. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting 1.5 feet or more above crown of pipe. Remove trench supports within 5 feet from ground surface.
- F. Place trench zone backfill in lifts and compact. Fully compact each lift before placement of next lift.
 - 1. Class I, II, III or IV or combination thereof (Random Backfill):

- a. Maximum 9-inches compacted lift thickness.
 - b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 698.
 - c. Moisture content within zero percent to +5 percent of optimum determined according to ASTM D 698, unless otherwise approved by Project Manager.
2. Cement-Stabilized Sand:
- a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but do not exceed 12 inches.
 - b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 558.
 - c. Moisture content on dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.
3. Select Backfill:
- a. Place in maximum 8-inch loose layers.
 - b. Compaction by equipment providing tamping or kneading impact to minimum of 95 percent of maximum dry density determined according to ASTM D 698.
 - c. Moisture content within 2 percent below or 5 percent above optimum determined according to ASTM D 698, unless approved by Project Manager.
- G. Unless otherwise shown on Drawings, for trench excavations not under pavement, random backfill of suitable material may be used in trench zone. This provision does not apply to HDPE storm sewers.
1. Fat clays (CH) may be used as trench zone backfill outside paved areas at Contractor's option. When required density is not achieved, at any additional cost to City, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements, or use different suitable material.
 2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.
 3. Compact to minimum of 90 percent of maximum dry density determined according to ASTM D 698.

4. Moisture content as necessary to achieve density.

H. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

A. Meet requirements of adjoining utility installations for backfill of pipeline structures, as shown on Drawings.

B. Below paved areas, encapsulate manhole with cement stabilized sand; minimum of 1 foot below base, minimum 1 foot around walls, up to within 12 inches of pavement subgrade. Compact in accordance with Paragraph 3.10.F.2 of this Section

C. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on Drawings. Deposit backfill in uniform layers and compact each layer as specified. Maintain backfill material at no less than 2 percent below nor more than 5 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698.

3.11 FIELD QUALITY CONTROL

A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.

B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to City.

C. Tests will be performed on minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity, or when requested by Project Manager.

D. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement- stabilized sand in accordance with ASTM D 558. Perform additional moisture-density relationship tests once a month or whenever there is noticeable change in material gradation or plasticity.

E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at following frequencies and conditions.

1. For open cut construction projects and auger pits: Unless otherwise approved by Project Manager, successful compaction to be measured by one test per 40 linear feet measured along pipe for compacted embedment and two tests per 40 linear feet measured along pipe for compacted trench zone backfill material. Length of auger pits to be measured to arrive at 40 linear feet.
 2. A minimum of three density tests for each full shift of Work.
 3. Density tests will be distributed among placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.
 4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.
 5. Density tests may be performed at various depths below fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
 6. Two verification tests will be performed adjacent to in-place tests showing density less than acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
 7. Recompacted placement will be retested at same frequency as first test series, including verification tests.
 8. Identify elevation of test with respect to natural ground or pavement.
- F. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.
- G. Acceptability of crushed rock compaction will be determined by inspection.
- 3.12 DISPOSAL OF EXCESS MATERIAL
- A. Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02319

BORROW

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Soil materials for embankment.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for borrow is on cubic yard basis calculated by theoretical quantities using average end area method based on Drawings.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.
- B. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit location and description of proposed borrow area for approval.
- C. Submit material samples for testing.

PART 2 P R O D U C T S

2.01 SOIL MATERIAL

- A. Grade borrow material used for embankment free of lumps greater than 6 inches, rocks larger than 3 inches, organic material, chemical waste or other contamination, and debris. Take borrow material from sources approved by Project Manager.
- B. Use material with plasticity index not less than 12, nor more than 20 when tested in accordance with ASTM D 4318. Maximum liquid limit shall be 45, unless approved by Project Manager. Do not use blend of cohesive and granular soils to achieve required plasticity index.

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify Project Manager and testing laboratory 5 days in advance of opening borrow source to permit obtaining samples for qualification testing. When material does not meet specification requirements, locate another source of borrow.
- B. Clear approved source area of trees, stumps, brush, roots, vegetation, organic matter, and other unacceptable material before excavation.

3.02 TESTS

- A. Test and analyze soil materials in accordance with ASTM D 4318 and ASTM D 2216 under provisions of Section 01454 - Testing Laboratory Services.

3.03 EXCAVATION

- A. Provide adequate drainage of surface water so that surface water run off does not enter borrow pit excavation.

3.04 HAULING

- A. Use covered trucks. Conform to requirements of Section 01555 - Traffic Control and Regulation.

3.05 EMBANKMENT

- A. Conform to requirements of Section 02330 - Embankment.

END OF SECTION

Section 02320

UTILITY BACKFILL MATERIALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Material Classifications.
- B. Utility Backfill Materials:
 - 1. Concrete sand
 - 2. Gem sand
 - 3. Pea gravel
 - 4. Crushed stone
 - 5. Crushed concrete
 - 6. Bank run sand
 - 7. Select backfill
 - 8. Random backfill

- C. Material Handling and Quality Control Requirements.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for backfill material. Include payment in unit price for applicable utility installation.
 - 2. Payment for backfill material, when included as separate pay item or when directed by Project Manager, is on cubic yard basis for material placed and compacted within theoretical trench width limits and thickness of material according to Drawings, or as directed by Project Manager.
 - 3. Payment for backfill of authorized over-excavation is in accordance with Section 02318 - Extra Unit Price Work for Excavation and Backfill.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

A. Unsuitable Material:

1. Materials classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
3. Materials containing large clods, aggregates, or stones greater than 4 inches in any dimension; debris, vegetation, or waste; or any other deleterious materials.
4. Materials contaminated with hydrocarbons or other chemical contaminants.

B. Suitable Material:

1. Materials meeting specification requirements.
2. Unsuitable materials meeting specification requirements for suitable soils after treatment with lime or cement.

C. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.

D. Foundation Base: Crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.

E. Backfill Material: Classified soil material meeting specified quality requirements for designated application as embedment or trench zone backfill.

F. Embedment Material: Soil material placed under controlled conditions within embedment zone extending vertically upward from top of foundation to an elevation 12 inches above top of pipe, and including pipe bedding, haunching and initial backfill.

G. Trench Zone Backfill: Classified soil material meeting specified quality requirements and placed under controlled conditions in trench zone from top of embedment zone to base course in paved areas or to surface grading material in unpaved areas.

- H. Foundation: Either suitable soil of trench bottom or material placed as backfill of over-excavation for removal and replacement of unsuitable or otherwise unstable soils.
- I. Source: Source selected by Contractor for supply of embedment or trench zone backfill material. Selected source may be project excavation, off-site borrow pits, commercial borrow pits, or sand and aggregate production or manufacturing plants.
- J. Refer to Section 02317 - Excavation and Backfill for Utilities for other definitions regarding utility installation by trench construction.

1.04 REFERENCES

- A. ASTM C 33 - Standard Specification for Concrete Aggregate.
- B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- C. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.
- D. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in Los Angeles Machine.
- E. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- F. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- G. ASTM D 1140 - Standard Test Method for Amount of Material in Soils Finer Than No. 200 Sieve.
- H. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- I. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- J. ASTM D 4643 - Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Method.
- K. TxDOT Tex-110-E - Determining Particle Size Analysis of Soils.
- L. TxDOT Tex-460-A - Material Finer Than 75 Φ m (No.200) Sieve In Mineral Aggregates (Decantation Test for Concrete Aggregates).

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

- B. Submit description of source, material classification and product description, production method, and application of backfill materials.
- C. Submit test results for samples of off-site backfill materials. Comply with Paragraph 2.03, Material Testing.
- D. Before stockpiling materials, submit copy of approval from landowner for stockpiling backfill material on private property.
- E. Provide delivery ticket which includes source location for each delivery of material that is obtained from off-site sources or is being paid as specific bid item.

1.06 TESTS

- A. Perform tests of sources for backfill material in accordance with Paragraph 2.03B.
- B. Verification tests of backfill materials may be performed by City in accordance with Section 01454 - Testing Laboratory Services and in accordance with Paragraph 3.03.

PART 2 PRODUCTS

2.01 MATERIAL CLASSIFICATIONS

- A. Classify materials for backfill for purpose of quality control in accordance with Unified Soil Classification Symbols as defined in ASTM D 2487. Material use and application is defined in utility installation specifications and Drawings either by class, as described in Paragraph 2.01B, or by product descriptions, as given in Paragraph 2.02.
- B. Class Designations Based on Laboratory Testing:
 - 1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
 - a. Plasticity index: non-plastic.
 - b. Gradation: D_{60}/D_{10} - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.
 - 2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines (GM, GP, SP, SM):
 - a. Plasticity index: non-plastic to 4.
 - b. Gradations:

1. Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.
 2. Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
 3. Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.
3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):
- a. Plasticity index: greater than 7.
 - b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.
4. Class IVA: Lean clays (CL).
- a. Plasticity Indexes:
 1. Plasticity index: greater than 7, and above A line.
 2. Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.
 - b. Liquid limit: less than 50.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
5. Class IVB: Fat clays (CH)
- a. Plasticity index: above A line.
 - b. Liquid limit: 50 or greater.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
6. Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to more restrictive class.

2.02 PRODUCT DESCRIPTIONS

- A. Soils classified as silt (ML) silty clay (CL-ML with PI of 4 to 7), elastic silt (MH), organic clay and organic silt (OL, OH), and organic matter (PT) are not acceptable as backfill materials. These soils may be used for site grading and restoration in unimproved areas as

approved by Project Manager. Soils in Class IVB, fat clay (CH) may be used as backfill materials where allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.

- B. Provide backfill material that is free of stones greater than 6 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to following limits for deleterious materials:
 - 1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C 142.
 - 2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C 123.
 - 3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C 40.
- C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in product specification, and approved by Project Manager, provided that physical property criteria are determined to be satisfactory by testing.
- D. Bank Run Sand: Durable bank run sand classified as SP, SW, or SM by Unified Soil Classification System (ASTM D 2487) meeting following requirements:
 - 1. Less than 15 percent passing number 200 sieve when tested in accordance with ASTM D 1140. Amount of clay lumps or balls may not exceed 2 percent.
 - 2. Material passing number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318: Plasticity index: not exceeding 7.
- E. Concrete Sand: Natural sand, manufactured sand, or combination of natural and manufactured sand conforming to requirements of ASTM C 33 and graded within following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

- F. Gem Sand: Sand conforming to requirements of ASTM C 33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	95 to 100
No. 4	60 to 80
No. 8	15 to 40

- G. Pea Gravel: Durable particles composed of small, smooth, rounded stones or pebbles and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
1/2"	100
3/8"	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

- H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:

1. Materials of one product delivered for same construction activity from single source, unless otherwise approved by Project Manager.
2. Non-plastic fines.

3. Los Angeles abrasion test wear not exceeding 45 percent when tested in accordance with ASTM C 131.
4. Crushed aggregate shall have minimum of 90 percent of particles retained on No. 4 sieve with 2 or more crushed faces as determined by Tex-460-A, Part I.
5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from naturally occurring single source. Uncrushed gravel is not acceptable materials for embedment where crushed stone is shown on applicable utility embedment drawing details.
6. Crushed Concrete: Crushed concrete is an acceptable substitute for crushed stone as utility backfill. Gradation and quality control test requirements are same as crushed stone. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate), or debris.
7. Gradations, as determined in accordance with Tex-110-E.

Sieve	Percent Passing by Weight for Pipe Embedment by Ranges of Nominal Pipes Sizes		
	>15"	15" - 8"	<8"
1"	95 - 100	100	-
3/4"	60 - 90	90 - 100	100
1/2"	25 - 60	-	90 - 100
3/8"	-	20 - 55	40 - 70
No. 4	0 - 5	0 - 10	0 - 15
No. 8	-	0 - 5	0 - 5

- I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with plasticity index between 7 and 20 or clayey soils treated with lime in accordance with Section 02951 - Pavement Repair and Resurfacing, to meet plasticity criteria.
- J. Random Backfill: Any suitable soil or mixture of soils within Classes I, II, III and IV; or fine grained clay (CH) where allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.

- K. Cement Stabilized Sand: Conform to requirements of Section 02321 - Cement Stabilized Sand.
- L. Concrete Backfill: Conform to Class B concrete as specified in Section 03315 - Concrete for Utility Construction.
- M. Flexible Base Course Material: Conform to requirements of applicable portions of Section 02711 - Hot Mix Asphaltic Base Course, Section 02712 - Cement Stabilized Base Course, and Section 02713 - Crushed Concrete Base Course.

2.03 MATERIAL TESTING

- A. Source Qualification. Perform testing to obtain tests by suppliers for selection of material sources and products not from the project site. Test samples of processed materials from current production representing material to be delivered. Use tests to verify that materials meet specification requirements. Repeat qualification test procedures each time source characteristics change or there is planned change in source location or supplier. Include the following qualification tests, as applicable:
 - 1. Gradation. Report complete sieve analyses regardless of specified control sieves from largest particle through No. 200 sieve.
 - 2. Plasticity of material passing No. 40 sieve
 - 3. Los Angeles abrasion wear of material retained on No. 4 sieve
 - 4. Clay lumps
 - 5. Lightweight pieces
 - 6. Organic impurities
- B. Production Testing. Provide reports to Project Manager from an independent testing laboratory that backfill materials to be placed in Work meet applicable specification requirements.
- C. Assist Project Manager in obtaining material samples for verification testing at source or at production plant.

PART 3 EXECUTION

3.01 SOURCES

- A. Use of existing material in trench excavations is acceptable, provided applicable specification requirements are satisfied.
- B. Identify off-site sources for backfill materials at least 14 days ahead of intended use so that Project Manager may obtain samples for verification testing.
- C. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet requirements of specifications will be rejected. Do not use material which, after approval, has become unsuitable for use due to segregation, mixing with other materials, or by contamination. Once material is approved by Project Manager, expense for sampling and testing required to change to different material will be credited to City through change order.
- D. Bank run sand, select backfill, and random backfill, if available in project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete work from off-site sources.
- E. City does not represent or guarantee that any soil found in excavation work will be suitable and acceptable as backfill material.

3.02 MATERIAL HANDLING

- A. When backfill material is obtained from either commercial or non-commercial borrow pit, open pit to expose vertical faces of various strata for identification and selection of approved material to be used. Excavate selected material by vertical cuts extending through exposed strata to achieve uniformity in product.
- B. Establish temporary stockpile locations for practical material handling, control, and verification testing by Project Manager in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.
- C. When stockpiling backfill material near project site, use appropriate covers to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering drainage system.
- D. Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

3.03 FIELD QUALITY CONTROL

- A. Quality Control
 - 1. The Project Manager may sample and test backfill at:
 - a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.

- b. On-site stockpiles.
 - c. Materials placed in Work.
 - 2. The Project Manager may re-sample material at any stage of work or location if changes in characteristics are apparent.
- B. Production Verification Testing: City's testing laboratory will provide verification testing on backfill materials, as directed by Project Manager. Samples may be taken at source or at production plant, as applicable.

END OF SECTION

Section 02330

EMBANKMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Construction of embankments with excess excavated material and borrow.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for embankment under this section. Include payment in unit price for excavation or borrow.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- B. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- C. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Refer to Section 02315 - Roadway Excavation for acceptable excess materials from roadway excavation.
- B. Refer to Section 02317 - Excavation and Backfill For Utilities for acceptable excess materials from utility excavation and trenching.

- C. Refer to Section 02319 - Borrow for acceptable borrow materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify borrow and excess excavated materials to be reused are approved.
- B. Verify removals and clearing and grubbing operations have been completed.

3.02 PREPARATION

- A. Backfill test pits, stump holes, small swales and other surface irregularities. Backfill and compact in designated lift depths to requirements for embankment compaction.
- B. Record location and plug and fill inactive water and oil wells. Conform to Texas State Health Department, Texas Commission on Environmental Quality and Texas Railroad Commission requirements. Notify City Engineer prior to plugging wells.
- C. Excavate and dispose of unsuitable soil and other unsuitable materials which will not consolidate. Backfill and compact to requirements for embankment. Unsuitable soil is defined in Section 02316 - Excavation and Backfill for Structures and Section 02320 - Utility Backfill Materials.
- D. Backfill new utilities below future grade. Conform to requirements of Sections 02317 - Excavation and Backfill For Utilities, 02511 - Water Lines, 02531 - Gravity Sanitary Sewers, and 02532 - Sanitary Sewage Force Mains.

3.03 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other features outside of embankment limits.
- B. Protect utilities above and below grade, which are to remain.
- C. Conform to protection requirements of Section 02315 - Roadway Excavation.

3.04 PLACING EMBANKMENT

- A. Do not conduct placement operations during inclement weather or when existing ground or fill materials exceed 3 percent of optimum moisture content. Contractor may manipulate wet material to facilitate drying, by disking or windrowing.

- B. Do not place embankment fill until density and moisture content of previously placed material comply with specified requirements.
- C. Scarify areas to be filled to minimum depth of 4 inches to bond existing and new materials. Mix with first fill layer.
- D. Spread fill material evenly, from dumped piles or windrows, into horizontal layers approximately parallel to finished grade. Place to meet specified compacted thickness. Break clods and lumps and mix materials by blading, harrowing, disking or other approved method. Extend each layer across full width of fill.
- E. Each layer shall be homogeneous and contain uniform moisture content before compaction. Mix dissimilar abutting materials to prevent abrupt changes in composition of fill.
- F. Layers shall not exceed the following compacted thickness:
 - 1. Areas indicated to be under future paving or shoulders, to be constructed within 6 months: 6 inches when compacted with pneumatic rollers, or 8 inches when compacted with other rollers.
 - 2. Other areas: 12 inches
- G. For steep slopes, cut benches into slope and scarify before placing fill. Place increasingly wider horizontal layers of specified depth to level of each bench.
- H. Build embankment layers on back slopes, adjacent to existing roadbeds, to level of old roadbed. Scarify top of old roadbed to minimum depth of 4 inches and recompact with next fill layer.
- I. Construct to lines and grades shown on Drawings.
- J. Remove unsuitable material and excess soil not being used for embankment from site in accordance with requirements of Section 01576 - Waste Material Disposal.
- K. Maintain moisture content of embankment materials to attain required density.
- L. Compact to following minimum densities at moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on Drawings:
 - 1. Areas under future paving and shoulders: Minimum density of 95 percent of maximum dry density.
 - 2. Other areas: Minimum density of 90 percent of maximum dry density.

3.06 TOLERANCES

- A. Top of compacted surface: Plus or minus 1/2 inch in cross section or 16 foot length.

3.07 FIELD QUALITY CONTROL

- A. Compaction Testing will be performed in accordance with ASTM D 698 or ASTM D 2922 and ASTM D 3017 under provisions of Section 01454 - Testing Laboratory Services.
- B. A minimum of three tests will be taken for each 1000 linear feet per lane of roadway or 500 square yards of embankment per lift.
- C. If tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at no cost to City.

END OF SECTION

SECTION 02466**DRILLED PIERS****PART 1 - GENERAL****1.01 SCOPE: Work included in this Section, while not all inclusive but listed as a guide, is as follows:**

- A. Drilling and casing holes if required, pumping water, cleaning piers, and removing spoil.
- B. Place reinforcing steel and concrete.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. REINFORCING STEEL: Section 03200
- B. CAST-IN-PLACE CONCRETE: Section 03300

1.03 MEASUREMENT AND PAYMENT:

- A. The unit prices (see bid form) shall include all labor, materials, overhead and profit for drilled piers complete including removal of spoil. If casing is required, cost will be added to the Contract based upon unit price basis for length of casing required per recommendations.

1.04 DIRECTIVES:

- A. Follow directives as given by Architect/Engineer or Testing Lab in relationship to existing on site conditions. Representative shall be on site throughout drilling process.

PART 2 - PRODUCTS**2.01 MATERIALS:**

- A. Concrete: Specified elsewhere
- B. Reinforcing Steel: Specified elsewhere
- C. Steel Casing: Steel material ASTM A-36 of sufficient strength to withstand handling stress, concrete pressure, and earth surcharge.

PART 3 - EXECUTION**3.01 DRILLING:**

- A. Drill pier holes with a power auger foundation drilling rig designed for that purpose. Bids shall be based on drilling at depths as shown. Accurately locate pier holes within one inch (1"). Drill to size and depth shown on Drawings. Sink piers vertically. Pier holes out of plumb more than one inch (1") in ten feet (10') with a maximum of two inches (2") will be rejected.

3.02 CASING PIER HOLES:

- A. If flowing water or caving soil is encountered, Contractor shall provide and place steel casings to seal off the flowing water or caving soil.

3.03 PUMPING AND CLEANING:

- A. After pier holes have been drilled to proper depth and the cutting edge of the casing is seated, if required, pump all water out. Clean bottoms of pier excavations of loose material and foreign matter and receive approval of the laboratory representative before concrete is deposited.

3.04 PLACING REINFORCING STEEL AND CONCRETE:

- A. Block reinforcement in concrete piers up off ground at least three inches (3") and firmly secure in place, free of contact with unformed sides.
- B. Provide steel dowels as detailed or scheduled. Reinforcement in piers, including dowels, shall be firmly secured in place, free of contact with the sides of drilled pier holes.

- C. Place concrete in each pier hole within eight hours after completion of drilling of same. Place concrete with use of a tremie and vibrate as required to fully embed reinforcing steel and eliminate voids, but not so much as to segregate aggregate.
- D. During the removal of the temporary steel casing from the hole during the concrete operation, exercise extreme care in its removal in order to insure that the head of plastic concrete is, at all times, greater than the head of surrounding ground water, and that no rotation or jerking of the casing be permitted during the withdrawal.

END OF SECTION

Section 02503

COPPER TUBING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Copper tubing for water service lines.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for copper tubing under this Section. Include cost in unit price for water taps and service lines.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.
- B. AWWA C 800 - Standard for Underground Service Line Valves and Fittings.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certified test results of ASTM B 88.
- C. Submit manufacturer's testing certification that copper tubing conforms to requirements of ASTM B 88. Number of samples for testing of each size of tubing is modified as follows:
 - 1. For each 7500 feet of tubing: 1 sample
 - 2. For each set of tubing less than 7500 feet: 1 sample

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Provide Type K annealed, seamless, copper tubing, 3/8 inch to 2 inch in diameter conforming to requirements of ASTM B 88.
- B. Provide 3/8-inch and 1-inch tubing in coils of minimum 60 feet in length, and 1 1/2-inch and 2-inch tubing in coils 40 feet in length.
- C. Provide tubing manufactured in United States of America. Tubing shall be inspected and tested by laboratory designated by Project Manager at point of manufacture or locally. Furnish tubing, at no additional cost to designated testing laboratory along with mill compliance certificates.
- D. Provide flared or compression-type brass fittings for use with Type K annealed copper tubing in accordance with AWWA C 800.

PART 3 E X E C U T I O N

3.01 INSTALLATION

- A. Conform to installation requirements of Section 02512 - Water Tap and Service Line Installation, except as modified in this Section.

3.02 JOINTS

- A. Minimum joint spacing for 3/4-inch and 1-inch tubing shall be 60 feet and for 1 1/2-inch and 2-inch tubing shall be 40 feet.
- B. Cut copper tubing squarely by using cutting tools designed specifically for purpose and avoid procedures that cause pipe to bend or pipe walls to flatten.
- C. After tubing has been cut, but before flaring, use reamer to remove inside rolled lip from tubing. Expand flared ends by use of flaring tool using care to avoid splitting, crimping, or over stressing metal. Provide at least 10 inches of straight pipe adjacent to fittings.
- D. When compression fittings are used, cut copper tubing squarely prior to insertion into fitting. Assemble in accordance with manufacturer's recommended procedure.

3.03 BENDS

- A. Bend tubing by using appropriate sized bending tool. No kinks, dents, flats, or crimps shall be permitted. Cut out and replace damaged section. Install no bends with radius smaller than radius of coil of tubing as packaged by manufacturer. Copper tubing shipped in straight lengths conforms to the following:
1. For 2-inch diameter: Maximum of one 45-degree bend per 4-foot section.
 2. For 1 1/2-inch diameter: Maximum of one 45-degree bend per 3-foot section.

END OF SECTION

Section 02505

**HIGH DENSITY POLYETHYLENE (HDPE)
SOLID AND PROFILE WALL PIPE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. High density polyethylene (HDPE) pipe for gravity sanitary sewers and drains, including fittings.
- B. High density polyethylene (HDPE) pipe for sanitary sewer force mains, including fittings.
- C. High density polyethylene (HDPE) pipe for gravity storm sewers and drains, including fittings.
- D. High density polyethylene (HDPE) pipe for storm sewers culverts.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for HDPE pipe under this Section. Include cost in unit prices for work, as specified in following sections:
 - a. Section 02531 - Gravity Sanitary Sewers.
 - b. Section 02532 - Sanitary Sewer Force Mains.
 - c. Section 02631 - Storm Sewers.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 618 - Standard Practice for Conditioning Plastics for Testing.
- B. ASTM D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

- C. ASTM D 2321 - Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Pipe.
- D. ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.
- E. ASTM D 2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
- F. ASTM D 3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
- G. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- H. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- I. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- J. ASTM F 714 - Standard Specification for Polyethylene Plastic (PE) Pipe (SDR-PR) Based on Outside Diameter.
- K. ASTM F 894 - Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.
- L. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
- M. ASTM F 2487 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene Pipelines.
- N. ASTM F 2510 – Standard Specification for Resilient Connectors between Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings showing design of pipe and fittings indicating alignment and grade, pipe length, laying dimensions, fabrication, fittings, flanges, gasket material, and special details.
- C. Submit detailed calculations for pipe design.

- D. Submit details of Pipe Joints and jointing procedure for HDPE pipe.

1.05 QUALITY CONTROL

- A. Provide manufacturer's certificate of conformance to Specifications.
- B. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.
- C. Project Manager reserves right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications.
 - 1. **Manufacturer's Notification:** Should Project Manager wish to witness manufacture of specific pipes, manufacturer shall provide Project Manager with minimum three weeks notice of when and where production of those specific pipes will take place.
 - 2. **Failure to Inspect.** Approval of products or tests is not implied by Project Manager's decision not to inspect manufacturing, testing, or finished pipes.
- D. Pipe manufacturer to provide services of experienced, competent, and authorized representative to visit site to advise and consult Contractor during jointing and installation of pipe.

1.06 QUALIFICATIONS

- A. **Manufacturer:** Company specializing in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed Work.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide products manufactured by companies listed on the City of Houston Standard Product List.
- B. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.
- C. Furnish profile-wall gravity sanitary sewer pipe with bell-and-spigot end construction conforming to ASTM D 3212. Joining will be accomplished with elastomeric gasket in

accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in pipe bell to form positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations.

- D. Furnish solid wall pipe for sanitary sewer force mains with minimum working pressure rating of 150 psi, and with inside diameter equal to or greater than nominal pipe size indicated on Drawings.
- E. Furnish corrugated profile-wall polyethylene (CPP) pipe for gravity storm sewer and storm sewer culvert pipe. Joints shall be installed such that connection of pipe sections will form continuous line free from irregularities in flow line. Suitable joints are:
 - 1. Integral Bell and Spigot. Bell shall overlap minimum of two corrugations of spigot end when fully engaged.
 - 2. Exterior Bell and Spigot. Bell shall be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged.

F. Jointing:

- 1. Gaskets:
 - a. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer, or blend of both.
 - b. Pipes allowed to be installed in potentially contaminated areas, where free product is found near elevation of proposed sewer, shall have the following gasket materials for noted contaminants:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer

- 2. Lubricant. Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.
- 3. Gravity Storm Sewer Watertight Joints: When required, watertight joints shall be in accordance with the requirements of ASTM D 3212.

2.02 MATERIALS FOR SANITARY SEWER

- A. Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Material meeting requirements of cell classification in accordance with ASTM D 3350 are also suitable for making pipe products under these specifications.
- B. Other Pipe Materials: Materials other than those specified in Paragraph 2.02A, Pipe and Fittings, may be used as part of profile construction, e.g., as core tube to support shape of profile during processing, provided that these materials are compatible with base polyethylene material and are completely encapsulated in finished product and in no way compromise performance of pipe products in intended use. Examples of suitable material include polyethylene and polypropylene.

2.03 MATERIALS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

- A. Pipe and Fittings: High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in ASTM D 3350. Manufacturing shall meet requirements of ASTM F 2306.

2.04 TEST METHODS FOR SANITARY SEWER

- A. Conditioning. Conditioning of samples prior to and during tests is subject to approval by Project Manager. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.
- B. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.05A, in suitable press until internal diameter has been reduced to 40 percent of original inside diameter of pipe. Rate of loading shall be uniform and at 2 inches per minute. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles.
- C. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace shear load transfer bars and supports with 6-inch-wide support blocks that can be either flat or contoured to conform to pipe's outer contour.
- D. Purpose of Tests. Flattening and joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

2.05 TEST METHODS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

- A. All testing and material requirements shall be in accordance with ASTM F 2306.

2.06 MARKING

- A. Mark each standard and random length of pipe in compliance with these Specifications with following information:
 - 1. Pipe size.
 - 2. Pipe class.
 - 3. Production code.
 - 4. Material designation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Conform to requirements of following Sections:
 - 1. Section 02550 - Sliplining Sanitary Sewers.
 - 2. Section 02531 - Gravity Sanitary Sewers.
 - 3. Section 02532 - Sanitary Sewage Force Mains.
 - 4. Section 02533 - Acceptance Testing for Sanitary Sewers.
 - 5. Section 02631 - Storm Sewers
- B. Install pipe in accordance with the manufacturers recommended installation procedures and ASTM D 2774.
- C. HDPE pipe is not approved in applications requiring augering of pipe.
- D. Bedding and backfill: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.
- E. Use only workmen trained in the installation of HDPE Pipe.
- F. Do not store pipe uncovered direct in direct sunlight. Allow pipe temperature to approach ground temperature before each individual pipe section is terminally connected.

- G. Joints: Join sections of HDPE pipe into continuous lengths above ground by thermal butt fusion method in accordance with AWWA C906 and pipe manufacturer's recommendations for specified service. Fusion joints: meeting minimum requirements of manufacturer for cool down time and other fusing requirements. Socket fusion and extrusion welding or hot gas welding will not be accepted.

- H. Cutting pipe: Comply with pipe manufacturer's recommendations. After cutting, leave end pipe in accordance with manufacturer's recommendations.

END OF SECTION

Section 02506

POLYVINYL CHLORIDE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Polyvinyl chloride pressure pipe for water distribution, in nominal diameters 4 inches through 20 inches.
- B. Polyvinyl chloride sewer pipe for gravity sewers in nominal diameters 4 inches through 48 inches.
- C. Polyvinyl chloride pressure pipe for gravity sewers and force mains in nominal diameters 4 inches through 20 inches.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for PVC pipe under this Section. Include cost in unit price for work included as specified in the following sections:
 - a. Section 02511 - Water Lines
 - b. Section 02531 - Gravity Sanitary Sewers
 - c. Section 02532 - Sanitary Sewer Force Mains
 - d. Section 02631 - Storm Sewers
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ANSI A 21.16 (AWWA C 116) - Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.
- B. ASTM D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

- C. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- D. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- E. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- F. ASTM D 2444 - Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
- G. ASTM D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- H. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- I. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- J. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- K. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- L. ASTM F 679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- M. ASTM F 794 - Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- N. ASTM F 949 - Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior and Fittings.
- O. AWWA C 110 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches for Water.
- P. AWWA C 111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- Q. AWWA C 900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches for Water Distribution.

- R. AWWA C 905 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In., for Water Transmission and Distribution.
- S. AWWA C 909 - Standard for Molecularly-Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 Inches through 12 Inches (100mm through 300 mm), for Water Distribution.
- T. PPI TR3 - Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
- U. UNI-B-13 - Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

1.05 QUALITY CONTROL

- A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C 900, AWWA C 909 and AWWA C 905 for pressure pipe applications, or appropriate ASTM standard specified for gravity sewer pipe.
- B. Submit manufacturer's certification that PVC pressure pipe for water lines and force mains has been hydrostatically tested at factory in accordance with AWWA C 900, AWWA C 909 and AWWA C 905, and this Section.
- C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from other source is not acceptable. Furnish copies of test reports to Project Manager for review. Cost of testing paid by Contractor.

PART 2 PRODUCTS

2.01 MATERIAL

- A. Use PVC compounds in manufacture of pipe that contain no ingredient in amount that has been demonstrated to migrate into water in quantities considered to be toxic.
- B. Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for rating of 4000 psi for water at 73.4 F per requirements of PPI TR3. Provide pipe which is homogeneous

throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.

- C. PVC Restrained Pipe: Must be listed on City's current Product Approval List.
 - 1. Pipe Material:
 - a. DR 18: For restrained joints where shown on Drawings.
 - b. DR 14: For alternate to offset pipe sections shown on Drawings. Do not use PVC for offset sections with depth of cover greater than 20 feet or less than 4 feet. Do not use PVC in potentially petroleum contaminated areas.
- D. Water Service.
 - 1. Provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.
 - 2. Bear National Sanitation Foundation Seal of Approval (NSF-PW).
- E. Gaskets:
 - 1. Gaskets shall meet requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.
 - 2. Flat Face Mating Flange: Full faces 1/8-inch-thick ethylene propylene (EPR) rubber.
 - 3. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EDR) rubber, with filler gasket between OD of raised face and flange OD to protect flange from bolting moment.
- F. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.
- H. Do not use PVC in potentially or known contaminated areas.
- I. Do not use PVC in areas exposed to direct sunlight.

2.02 WATER SERVICE PIPE

- A. Pipe 4 inch through 12 inch: AWWA C 900, AWWA C 909, Class 150, DR 18; AWWA C 900, Class 200, DR 14 as alternate to offset pipe sections; nominal 20-foot lengths; cast-iron equivalent outside diameters.
- B. Pipe 14 inch through 20 inch: AWWA C 905; Class 235; DR 18; nominal 20-foot lengths; cast-iron equivalent outside diameter.
- C. Provide Polyvinyl Chloride Pipe from approved manufacturers.
- D. Make curves and bends by deflecting joints. Do not exceed maximum deflection recommended by pipe manufacturer. Submit details of other methods of providing curves and bends for review by Project Manager.
- E. Hydrostatic Test: AWWA C 900, AWWA C 905, AWWA C 909, ANSI A 21.10 (AWWA C 110); at point of manufacture; submit manufacturer's written certification.

2.03 GRAVITY SEWER PIPE

- A. PVC gravity sanitary sewer pipe and storm sewer pipe shall be in accordance with provisions in following table:

WALL CONSTRUCTION	MANUFACTURER	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed Diamond Uponor ETI North American	D3034	SDR 26 / PS 115	6" to 10"
		D3034	SDR 35 / PS 46	12" & 15"
		F679	SDR 35 / PS 46	18" to 27"
		AWWA C900	DR 18 / N/A	4" to 12"
		AWWA C909	DR 18 / N/A	4" to 12"
		AWWA C905	DR 18 / N/A	14" to 16"
Truss (Gasketed)	Contech	D2680	N/A /200 psi	8" to 15"
Profile	Contech A-2000	F949	N/A / 46 psi	12" to 36"
	Contech A-2026	F949	N/A / 115 psi	8" to 10"
	ETI, Ultra-Rib	F794	N/A / 46 psi	8" to 30"
	ETI, Ultra-Corr	F794	N/A / 46 psi	24" to 36"

- B. When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM F 679, except provide wall thickness as required for SDR 26 and pipe strength of 115 psi.
- C. For sewers up to 12-inch diameter crossing over water lines, or crossing under water lines with less than 2-foot separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.
- D. Joints: Spigot and integral wall section bell with solid cross section elastomeric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477, or ASTM D 3139 and ASTM F 477. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. Manufacturer shall test sample from each batch conforming to requirements ASTM D 2444.
- E. Fittings: Provide PVC gravity sewer sanitary bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.
- F. Conditioning. Conditioning of samples prior to and during tests is subject to approval by Project Manager. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.
- G. Pipe Stiffness. Determine pipe stiffness at 5 percent deflection in accordance with Test Method D 2412. Minimum pipe stiffness shall be 46 psi. For diameters 4 inches through 18 inches, test three specimens, each a minimum of 6 inches (152 mm) in length. For diameters 21 inch through 36 inch, test three specimens, each a minimum of 12 inch (305 mm) in length.
- H. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.04F, in suitable press until internal diameter has been reduced to 60 percent of original inside diameter of pipe. Rate of loading shall be uniform. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles. Perform the flattening test in conjunction with pipe stiffness test.
- I. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except that joint shall remain watertight at minimum deflection of 5 percent. Manufacturer will be required to provide independent third party certification for joint testing each diameter of storm sewer pipe.
- J. Purpose of Tests. Flattening and pipe stiffness tests are intended to be routine quality control tests. Joint tightness test is intended to qualify pipe to specified level of performance.

2.04 SANITARY SEWER FORCE MAIN PIPE

- A. Provide approved PVC pressure pipe conforming to requirements for water service pipe, and conforming to minimum working pressure rating specified in Section 02532 - Sanitary Sewage Force Mains.
- B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use approved joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.
- C. Fittings: Provide approved ductile iron fittings as per Section 02501 - Ductile Iron Pipe and Fittings, Paragraph 2.04, except furnish fittings with one of following approved internal linings:
 - 1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to interior surface of fitting
 - 2. Nominal 40 mils (35 mils minimum) polyurethane
 - 3. Nominal 40 mils (35 mils minimum) ceramic epoxy
 - 4. Nominal 40 mils (35 mils minimum) fusion bonded epoxy
- D. Exterior Protection: Provide polyethylene wrapping of ductile-iron fittings as required by Section 02528 - Polyethylene Wrap.
- E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Paragraph 2.02E.

2.05 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

- A. Bends and Fittings: ANSI A 21.10 or ANSI A 21.53, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating. Approved restrained joints, 250 200 psi, may be provided for up to 12 inches in diameter (water or sanitary).
- B. Provide approved restrained joint fittings: Integral restrained joint fittings and pipe do not require secondary restraint.

PART 3 EXECUTION

3.01 PROTECTION

- A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with manufacturer's recommendations.

3.02 INSTALLATION

- A. Conform to requirements of Section 02511 - Water Lines, Section 02531 - Gravity Sanitary Sewers, and Section 02532 - Sanitary Sewer Force Mains, as applicable.
- B. Install PVC pipe in accordance with Section 02317 - Excavation and Backfill for Utilities, ASTM D 2321 for Sewer Pipe, and manufacturer's recommendations.
- C. Install PVC water service pipe to clear utility lines and have minimum depth of cover below property line grade of street, unless otherwise required by Drawings:
 - 1. Water service pipe 12 inches in diameter and smaller 4 feet of cover.
 - 2. Water service pipe 16 inches in diameter and larger 5 feet of cover.
- D. Avoid imposing strains that will overstress or buckle pipe when lowering pipe into trench.
- E. Hand shovel pipe bedding under pipe haunches and along sides of pipe barrel and compact to eliminate voids and ensure side support.
- F. Store PVC pipe under cover out of direct sunlight. Protect pipe from excessive heat or harmful chemicals. Prevent damage by crushing or piercing.
- G. Allow PVC pipe to cool to ground temperature before backfilling when assembled out of trench to prevent pullout due to thermal contraction.

3.03 PVC RESTRAINED MECHANISM

- A. Do not apply lubricant to spline or pipe or coupling spline grooves.
- B. Do not use excessive force while inserting the spline through coupling.
- C. Insert spline until it is fully seated around circumference of pipe.
- D. Field Cutting of Pipe Ends:
 - 1. Perform by workers certified by manufacturer.

2. Use a PVC pipe cutter and provide square ends.
3. Use manufacturer approved power routing and grooving tool to field fabricate required pipe groove.

END OF SECTION

Section 02511

WATER LINES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Installation of water lines.
- B. Specifications identify requirements for both small diameter water lines and large diameter water lines. When specifications for large diameter water lines differ from those for small diameter water lines, large diameter specifications will govern for large diameter pipe.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for water lines installed by open-cut, augered with or without casing, aerial crossing, and pipe offset section or within limits of Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis for each size of pipe installed. Separate pay items are used for each type of installation.
 - a. Mains: Measure along axis of pipe and include fittings and valves.
 - b. Branch Pipe: Measure from axis of water line to end of branch.
 - 2. Payment for interconnection is on lump sum basis for each interconnection identified on Drawings. Payment will include tapping sleeve and valves piping, connections and other related work necessary for construction as shown on Drawings or specified herein.
 - 3. Payment for removal of existing internal elliptical or dished head plug is on unit price basis for each internal elliptical or dished head plug removed. Payment will include deletion of plug, drainage or dewatering of water lines, repair of damaged linings, rechlorination and items incidental to operation.
 - 4. Payment for plug and clamp is on a unit price basis for each size of pipe.
 - 5. Payment for drainline connection with service manhole is on unit price basis for each drainline shown on drawings. Payment includes valve, access manhole and connection.
 - 6. Payment for cylindrical corrosion barriers is on a unit price basis for each pipe fitting installed with one or more barriers.

7. When directed by Project Manager to install extra fittings as required to avoid unforeseen obstacles, payment will be based on the following:
 - a. Each extra fitting requested by Project Manager and delivered to jobsite will be paid according to unit price for "Extra Fittings in Place."
 - b. Payment will include and be full compensation for items necessary for installation and operation of water line.

8. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile - Iron Pressure Pipe and Fittings.
- B. ANSI/NSF Standard 61 - Drinking Water System -Health Components.
- C. ASTM A 36 - Standard Specification for Carbon Structural Steel
- D. ASTM A 536 - Standard Specification for Ductile Iron Castings
- E. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- F. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.
- G. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
- H. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.
- I. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.
- J. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination
- K. ASTM E 709 - Standard Guide for Magnetic Particle Examination
- L. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
- M. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.

- N. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Conform to submittal requirements of applicable Section for type of pipe used.
- C. Photographs: Submit photographs conforming to requirements of Section 01321 - Construction Photographs prior to commencement of construction.
- D. Submit videotapes conforming to requirements of Section 01323 - Construction Videotapes, if applicable.
- E. Submit Lone Star notification transmittal number prior to beginning excavation.
- F. Submit, a minimum of 15 days before beginning pipe laying operations, layout drawing identifying proposed sections for disinfecting, hydrostatic testing and site restoration for entire project for review and approval. Layout drawing to identify sequence of sections for:
 - 1. Disinfection; not to exceed 4,000 linear feet per section.
 - 2. Hydrostatic testing and transfer of services; to immediately follow sequence of disinfected section.
 - 3. Site restoration; not to exceed limits specified; Sequence in order of disturbance.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

- A. Install pipe materials which conform to following:
 - 1. Section 02501 - Ductile Iron Pipe and Fittings.
 - 2. Section 02502 - Steel Pipe and Fittings. Water line piping within plant site and aerial crossings to be welded joint steel pipe with flange or approved restraint joint connections, unless otherwise shown on Drawings.
 - 3. Section 02506 - Polyvinyl Chloride Pipe.
 - 4. Section 02507 - Prestressed Concrete Cylinder Pipe.

5. Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.
 6. Section 02613 - Bar-Wrapped Steel Cylinder Pipe.
- B. Conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have certified by an organization accredited by ANSI.
- C. Type of pipe materials used is Contractor's option unless specifically identified on Drawings.
- D. Provide minimum of 3/8 inch inside joint recess between ends of pipe in straight pipe sections.
- 2.02 WELDED JOINT PROTECTION FITTING FOR SMALL DIAMETER STEEL PIPE
- A. Cylindrical Corrosion Barrier: Provide approved cylindrical corrosion barrier.
 - B. O-rings: Conform to National Sanitary Foundation requirements.
- 2.03 RESTRAINED JOINTS
- A. Ductile-Iron Pipe: See Section 02501 - Ductile Iron Pipe and Fittings.
 - B. PVC Pipe: See Section 02506 - Polyvinyl Chloride Pipe. Perform hydrostatic testing in accordance with ASTM F 1674.
 - C. Prestressed Concrete Cylinder Pipe, Bar-Wrapped Pipe and Steel Pipe: Welded joints (see Paragraph 3.06 D).
 - D. Restrained Joints where required on DIP and PVC pipe:
 1. Restraint devices: Manufacture of high strength ductile iron, ASTM A 536 up to 24 inches, and ASTM A 36 for sizes greater than 30 inches. Working pressure rating twice that of design test pressure.
 2. Bolts and connecting hardware: High strength low alloy material in accordance with ANSI A21.11/AWWA C111.
- 2.04 COUPLINGS AND APPURTENANCES FOR LARGE DIAMETER WATERLINE
- A. Flexible (Dresser-type) Couplings.
 1. Install where shown on Drawings or where allowed by Project Manager for Contractor's convenience. Use galvanized flexible couplings when installed on galvanized pipe which is cement lined, or when underground. Provide gaskets manufactured from Neoprene or Buna-N.

2. For steel pipe; provide approved sleeve-type flexible couplings. Thickness of middle ring equal to or greater than thickness of pipe wall.
 3. Provide approved flanged adapter couplings for steel pipe
 4. Use Type 316 stainless steel bolts, nuts and washers where flexible couplings are installed underground. Coat entire coupling with 20-mil of approved coal tar coating.
- B. Flap Valves: Provide approved flap valves on discharge of manhole drainline as shown on Drawings.
1. Body and Flap: ASTM A 126-B cast iron.
 2. Seats: ASTM B 21-CA482 or ASTM B 301-CA145 bronze.
 3. Resilient Seat:
 4. Hinge Arms: ASTM B 584-CA865 high tensile bronze.
 5. Hinge pins: ASTM B 98-CA655 silicon bronze.

PART 3 EXECUTION

3.01 PREPARATION

- A. Conform to applicable installation specifications for types of pipe used.
- B. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished. Provide watertight pipe and pipe joints.
- C. Lay pipe to lines and grades shown on Drawings.
- D. Confirm that nine feet minimum separation from gravity sanitary sewers and manholes or separation of four feet minimum from force mains as specified in this Section in all directions unless special design is provided on Drawings.
- E. Where above clearances cannot be attained, and special design has not been provided on Drawings, obtain direction from Project Manager before proceeding with construction.
- F. Inform Project Manager if unmetered sprinkler or fire line connections exist which are not shown on Drawings. Make transfer only after approval by Project Manager.

- G. For projects involving multiple subdivisions or locations, limit water line installation to maximum of two project site locations. Maximizing 2 pipe installation crews shall be permitted, unless otherwise approved by Project Manager.
- H. City of Houston Utility Operations Division will handle, at no cost to Contractor, operations involving opening and closing valves for wet connections and for chlorination. Contractor is responsible for handling necessary installations and removal of chlorination and testing taps and risers.
- I. If asbestos-cement (A.C.) pipe is encountered, follow safety practices outlined in American Water Works Association's publication, "Work Practices for A/C Pipe". Strictly adhere to "recommended practices" contained in this publication and make them "mandatory practices" for this Project.
- J. For pipe diameters 36 inches and greater, clearly mark each section of pipe and fitting with unique designation on inside of pipe along with pressure class. Locate unique identifying mark minimum of five feet away from either end of each section of pipe. Provide one unique identifying mark in middle of each fitting. Place markings at consistent locations. Use permanent black paint and minimum letter height of 4 inches to mark designations.
- K. Contractor is responsible for assuring chosen manufacturer fulfills requirements for extra fittings and, therefore, is responsible for costs due to downtime if requirements are not met.
- L. Do not remove plugs or clamps during months of peak water demands; June, July and August, unless otherwise approved by Project Manager.

3.02 HANDLING, CLEANING AND INSPECTION

- A. Handling:
 - 1. Place pipe along project site where storm water or other water will not enter or pass through pipe.
 - 2. Load, transport, unload, and otherwise handle pipe and fittings to prevent damage of any kind. Handle and transport pipe with equipment designed, constructed and arranged to prevent damage to pipe, lining and coating. Do not permit bare chains, hooks, metal bars, or narrow skids or cradles to come in contact with coatings. Where required, provide pipe fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.
 - 3. Hoist pipe from trench side into trench by means of sling of smooth steel cable, canvas, leather, nylon or similar material.
 - 4. For large diameter water lines, handle pipe only by means of sling of canvas, leather, nylon, or similar material. Sling shall be minimum 36 inches in width. Do not tear or wrinkle tape layers.

5. Use precautions to prevent injury to pipe, protective linings and coatings.
 - a. Package stacked pipe on timbers. Place protective pads under banding straps at time of packaging.
 - b. Pad fork trucks with carpet or other suitable material. Use nylon straps around pipe for lift when relocating pipe with crane or backhoe.
 - c. Do not lift pipe using hooks at each end of pipe.
 - d. Do not place debris, tools, clothing, or other materials on pipe.
 6. Repair damage to pipe or protective lining and coating before final acceptance.
 7. For cement mortar line and coated steel pipe and PCCP, permit no visible cracks longer than 6 inches, measured within 15 degrees of line parallel to pipe longitudinal axis of finished pipe, except:
 - a. In surface laitance of centrifugally cast concrete.
 - b. In sections of pipe with steel reinforcing collars or wrappers.
 - c. Within 12 inches of pipe ends.
 8. Reject pipe with visible cracks (not meeting exceptions) and remove from project site.
- B. Cleaning: Thoroughly clean and dry interior of pipe and fittings of foreign matter before installation, and keep interior clean until Work has been accepted. Keep joint contact surfaces clean until jointing is completed. Do not place debris, tools, clothing or other

materials in pipe. After pipe laying and joining operations are completed, clean inside of pipe and remove debris.

- C. Inspection: Before installation, inspect each pipe and fitting for defects. Reject defective, damaged or unsound pipe and fittings and remove them from site.

3.03 EARTHWORK

- A. Conform to applicable provisions of Section 02317 - Excavation and Backfilling for Utilities and Section 02447 - Augering Pipe and Conduit.
- B. Bedding: Use bedding materials in conformance with Section 02320 - Utility Backfill Materials.
- C. Backfill: Use bank run sand or earth or native soil as specified in Section 02320 - Utility Backfill Materials. Backfill excavated areas in same day excavated. When not possible, cover excavated areas using steel plates on paved areas and other protective measures elsewhere.
- D. Place material in uniform layers of prescribed maximum loose thickness and wet or dry material to approximately optimum moisture content. Compact to prescribed density Water tamping is not allowed.
- E. Pipe Embedment: Including 6-inch pipe bedding and backfill to 12 inches above top of pipe.

3.04 PIPE CUTTING

- A. Cut pipe 12 inches and smaller with standard wheel pipe cutters. Cut pipe larger than 12 inches in manner approved by Project Manager. Make cuts smooth and at right angles to axis of pipe. Bevel plain end with heavy file or grinder to remove sharp edges.

3.05 PIPING INSTALLATION

- A. General Requirements:
 1. Lay pipe in subgrade free of water.
 2. Make adjustments of pipe to line and grade by scraping away subgrade or filling in with granular material.
 3. Properly form bedding to fully support bell without wedging or blocking up bell.
 4. Open Cut Construction: Keep pipe trenches free of water which might impair pipe laying operations. Grade pipe to provide uniform support along bottom of pipe. Excavate for bell holes after bottom has been graded and in advance of placing pipe. Lay not more than nominal city block length of not more than 300 feet of pipe in trench ahead of backfilling operations. Cover or backfill laid pipe if pipe laying

operations are interrupted and during non-working hours. Place backfill carefully and simultaneously on each side of pipe to avoid lateral displacement of pipe and damage to joints. If adjustment of pipe is required after it has been laid, remove and re-lay as new pipe.

- B. Install pipe continuously and uninterrupted along each street on which work is to be performed. Obtain approval of Project Manager prior to skipping any portion of Work.
- C. Protection of Pipeline: Securely place stoppers or bulkheads in openings and in end of line when construction is stopped temporarily and at end of each day's work.
- D. Perform Critical Location as shown on Drawings. Refer to Section 02317 - Excavation and Backfill for Utilities for additional requirements at critical locations.
- E. Laying Large Diameter Water Line
 - 1. Lay not more than 50 feet of pipe in trench ahead of backfilling operations.
 - 2. Dig trench proper width as shown. When trench width below top of pipe becomes 4 feet wider than specified, install higher class of pipe or improved bedding, as determined by Project Manager. No additional payment will be made for higher class of pipe or improved bedding.
 - 3. Use adequate surveying methods and equipment; employ personnel competent in use of this equipment. Horizontal and vertical deviations from alignment as indicated on Drawings shall not exceed 0.10 feet. Measure and record "as-built" horizontal alignment and vertical grade at maximum of every 100 feet on record drawings.
 - 4. Prevent damage to coating when placing backfill. Use backfill material free of large rocks or stones, or other material which could damage coatings.
 - 5. Before assembling couplings, lightly coat pipe ends and outside of gaskets with cup grease or liquid vegetable soap to facilitate installation.
 - 6. Prior to proceeding with critical tie-ins submit sequence of work based on findings from "critical location" effort.
- F. Perform following additional procedures when working on plant sites.
 - 1. Seventy-two hours prior to each plant shut down or connection, schedule coordination meeting with Project Manager and Water Production personnel. At this meeting, present proposed sequencing of Work and verification of readiness to complete Work as required and within time permitted. Do not proceed with Work until Project Manager agrees key personnel, equipment and materials are on hand to complete Work.

2. Prior to fully excavating around existing piping, excavate as minimal as possible to confirm type and condition of existing joints. Verify size, type, and condition of pipe prior to ordering materials or fully mobilizing for Work.
3. Do not proceed with connections to existing piping and identified critical stages of work unless approved by Project Manager and City's Utility Maintenance Division operator is present to observe.
4. Coordinate with City's Water Production Division operators to obtain reduction in operating pressures prior to performing connections to existing piping.
5. Make connections to existing piping only when two valves are closed off between connection and source of water pressure. Do not make connection relying solely on one valve, unless otherwise approved by Project Manager.
6. Perform critical stages of Work identified on Drawings at night or during low water demand months as specified in Section 01110 - Summary of Work.
7. Excavation equipment used on plant sites to have smooth bucket; no teeth or side cutters.
8. Submit to Project Manager Lone Star Notification transmittal number prior to beginning excavation.
9. Before each "dig" with mechanical excavator, probe ground to determine potential obstructions. Repeat procedure until existing pipe is located or excavation reaches desired elevation. Perform excavations within one foot to existing piping by hand methods.
10. Provide adequate notice to pipe manufacture's representative when connecting or modifying existing prestressed or pretension concrete cylinder pipe.
11. Provide field surveyed (horizontal and vertical elevations) "as-builts" of new construction and existing underground utilities encountered. Submit in accordance with Section 01330 - Submittal Procedures.
12. Prior to performing plant work to be done on weekend, provide list of sites and contact person with phone numbers to Project Manager by noon on Thursday of week. Contact person must be accessible during weekend, have Houston Metro Area phone number, and be authorized to make emergency decisions.
13. No night work or plant shut down will be scheduled to begin two working days before or after designated City Holidays.

- G. For tie-ins to existing water lines, provide necessary material on hand to facilitate connection prior to shutting down existing water line. Provide City a minimum of two weeks notice prior to shutting down existing water line.

3.06 JOINTS AND JOINTING

- A. Rubber Gasketed Bell-and-Spigot Joints for Concrete Cylinder Pipe, Bar Wrapped Pipe PVC, Steel, and DIP:

1. After rubber gasket is placed in spigot groove of pipe, equalize rubber gasket cross section by inserting tool or bar recommended by manufacturer under rubber gasket and moving it around periphery of pipe spigot.
2. Lubricate gaskets with nontoxic water-soluble lubricant before pipe units are joined.
3. Fit pipe units together in manner to avoid twisting or otherwise displacing or damaging rubber gasket.
4. After pipe sections are joined, check gaskets to ensure that no displacement of gasket has occurred. If displacement has occurred, remove pipe section and remake joint as for new pipe. Remove old gasket, inspect for damage and replace if necessary before remaking joint.
5. Where preventing movement of 16-inch diameter or greater pipe is necessary due to thrust, use restrained joints as shown on Drawings.
 - a. Include buoyancy conditions for soil unit weight when computing thrust restraint calculations.
 - b. Do not include passive resistance of soil in thrust restraint calculations.
6. Except for PVC pipe, provide means to prevent full engagement of spigot into bell as shown on Drawings. Means may consist of wedges or other types of stops as approved by Project Manager.

- B. Flanged Joints where required on Concrete Cylinder Pipe, Bar Wrapped Pipe, Ductile Iron Pipe, or Steel Pipe:

1. AWWA C 207. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align

bolt holes to straddle vertical, horizontal or north-south center line. Do not exceed 3/64 inch per foot inclination of flange face from true alignment.

2. Use full-face gaskets for flanged joints. Provide 1/8-inch-thick cloth inserted rubber gasket material. Cut gaskets at factory to proper dimensions.
3. Use galvanized or black nuts and bolts to match flange material. Use cadmium-plated steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Maintain at all times approximately same distance between two flanges at points around flanges. Tighten bolts alternately (180° apart) until all are evenly tight. Draw bolts tight to ensure proper seating of gaskets. Provide Densco petroleum based tape or approved equal for all exposed portions of nuts, bolts and pipe.
4. Full length bolt isolating sleeves and washers shall be used with flanged connections. Furnish kits in accordance with City's "Approved Products List."
5. For in-line flange joints 30 inches in diameter and greater and at butterfly valve flanges, provide Pyrox G-10 with nitrite seal, conforming to ANSI A 21.11 mechanical joint gaskets. For in-line flange joints sized between 12 inches in diameter and greater and 24 inches in diameter and smaller, provide Phenolic PSI with nitrite seal gasket conforming to ANSI A 21.11 mechanical joint gaskets.

C. Welded Joints (Concrete Cylinder Pipe, Bar Wrapped Pipe, Steel Pipe):

1. Prior to starting work, provide certification of qualification for welders employed on project for type of work procedures and positions involved.
2. Joints: AWWA C 206. Full-fillet, single lap-welded slip-type either inside or outside, or double butt-welded type; use automatic or hand welders; completely penetrate deposited metal with base metal; use filler metal compatible with base metal; keep inside of fittings and joints free from globules of weld metal which would restrict flow or become loose. Do not use mitered joints. For interior welded joints, complete backfilling before welding. For exterior field-welded joints, provide adequate working room under and beside pipe. Use exterior welds for 30-inch and smaller.
3. Furnish welded joints with trimmed spigots and interior welds for 36-inch and larger pipe.
4. Bell-and-spigot, lap-welded slip joints: Deflection may be taken at joint by pulling joint up to 3/4 inch as long as 1 1/2 inch minimum lap is maintained. Spigot end may be miter cut to take deflections up to 5 degrees as long as joint tolerances are maintained. Miter end cuts of both ends of butt-welded joints may be used for joint deflections of up to 5 degrees.

5. Align piping and equipment so that no part is offset more than 1/8 inch. Set fittings and joints square and true, and preserve alignment during welding operation. For butt welded joints, align abutting ends to minimize offset between surfaces. For pipe of same nominal wall thickness, do not exceed 1/16 inch offset. Use line-up clamps for this purpose; however, take care to avoid damage to linings and coatings.
6. Protect coal-tar-epoxy lining during welding by draping an 18-inch-wide strip of heat resistant material over top half of pipe on each side of lining holdback to avoid damage to lining by hot splatter. Protect tape coating similarly if external welding is required.
7. Welding rods: Compatible with metal to be welded to obtain strongest bond, E-70XX.
8. Deposit metal in successive layers to provide at least 2 passes or beads for automatic welding and 3 passes or beads for manual welding in completed weld.
9. Deposit no more than 1/4 inch of metal on each pass. Thoroughly clean each individual pass with wire brush or hammer to remove dirt, slag or flux.
10. Do not weld under weather condition that would impair strength of weld, such as wet surface, rain or snow, dust or high winds, unless work is properly protected.
11. Make tack weld of same material and by same procedure as completed weld. Otherwise, remove tack welds during welding operation.
12. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, or valves.
13. Welded Joints for Large Diameter Water Lines:
 - a. Furnish pipe with trimmed spigots and interior welds for 36-inch and larger pipe.
 - b. Use exterior welds for 30 inch and smaller.
 - c. Only one end may be miter cut. Miter end cuts of both ends of butt-welded joints may be used for joint deflections of up to 2 ½ degrees.
 - d. For large diameter water lines, employ an independent certified testing laboratory, approved by Project Manager, to perform weld acceptance tests on welded joints. Include cost of such testing and associated work to accommodate testing in contract unit price bid for water line. Furnish copies of test reports to Project Manager for review. Project Manager has final decision as to suitability of welds tested.
 - 1) Weld acceptance criteria:

- a) Conduct in accordance with ASTM E165- Standard Test Method for Liquid Penetrant Examination and ASTM E709 Standard Guide for Magnetic Particle Examination. Use X-ray methods for butt welds, for 100 percent of joint welds.
 - b) Examine welded surfaces for the following defects:
 - i) Cracking.
 - ii) Lack of fusion/penetration.
 - iii) Slag which exceeds one-third (t) where (t) equals material thickness.
 - iv) Porosity/Relevant rounded indications greater than 3/16 inch; rounded indication is one of circular or elliptical shape with length equal to or less than three times its width.
 - v) Relevant linear indications in which length of linear indication exceeds three times its width.
 - vi) Four or more relevant 1/16-inch rounded indications in line separated by 1/16 inch or less edge to edge.
14. After pipe is joined and prior to start of welding procedure, make spigot and bell essentially concentric by jacking, shimming or tacking to obtain clearance tolerance around periphery of joint except for deflected joints.
15. Furnish each welder employed steel stencil for marking welds, so work of each welder can be identified. Mark pipe with assigned stencil adjacent to weld. When welder leaves job, stencil must be voided and not duplicated. Welder making defective welds must discontinue work and leave project site. Welder may return to project site only after recertification.
16. Provide cylindrical corrosion barriers for epoxy lined steel pipe 24-inch diameter and smaller, unless minimum wall thickness is 0.5 inches or greater.

- a. In addition to welding requirements contained here in Paragraph 3.06, conform to protection fitting manufacturer's installation recommendations.
 - b. Provide services of technical representative of manufacturer available on site at beginning of pipe laying operations. Representative to train welders and advise regarding installation and general construction methods. Welders must have 12 months prior experience installing protection fittings.
 - c. All steel pipe is to have cutback 3/4 inch to no greater than 1 inch of internal diameter coating from weld level.
 - d. Furnish steel fittings with cylindrical corrosion barriers with shop welded extensions to end of fittings. Extension length to measure no less than diameter of pipe. Shop apply lining in accordance with AWWA C 210 or AWWA C 213.
 - e. All steel pipe receiving field adjustments are to be cold cut using standard practices and equipment. No cutting using torch is to be allowed.
- D. Harnessed Joints (Concrete Cylinder Pipe, Bar Wrapped Pipe):
1. Use of snap-ring type restrained joints on pipe is limited to 20-inch through 48-inch diameters.
 2. Position snap-ring joint bolt on top (12 o'clock portion). Provide minimum 1/2-inch joint recess. Use joint "diapers" minimum of 12 inches wide.
 3. For field adjustments with deflections beyond manufacturer's recommendations:
 - a. Field trim spigot.
 - b. Do not engage ring.
 4. Harnessed joints are not permitted in areas defined on Drawings as potentially petroleum contaminated material, in tunnels, or at bend greater than 5 degrees.
 5. Install harness type joints including snap rings at straight sections of pipe.
- E. Restrained Joints
1. For existing water lines and water lines less than 16 inches in diameter, restrain pipe joints with concrete thrust blocks.
 2. Thrust restraint lengths shown on Drawings are minimum anticipated lengths. These lengths are based on deflections indicated and on use of prestressed concrete cylinder

pipe for large diameter lines and ductile iron pipe for small diameter lines. Adjustments in deflections or use of other pipe material may result in reduction or increase of thrust lengths. Perform calculations by pipe manufacturer to verify proposed thrust restraint lengths. Submit calculations for all pipe materials sealed by a registered Professional Engineer in State of Texas for review by Project Manager. Make adjustments in thrust restraint lengths at no additional cost to City.

3. Passive resistance of soil will not be permitted in calculation of thrust restraint.
4. For 16-inch lines and larger use minimum 16-foot length of pipe in and out of joints made up of beveled pipe where restraint joint lengths are not identified on Drawings. Otherwise, provide restraint joints for a minimum length of 16 feet on each side of beveled joints.
5. Installation.
 - a. Install restrained joints mechanism in accordance with manufacturer's recommendations.
 - b. Examine and clean mechanism; remove dirt, debris and other foreign material.
 - c. Apply gasket and joint NSF 61 FDA food grade approved lubricant.
 - d. Verify gasket is evenly seated.
 - e. Do not over stab pipe into mechanism.
6. Prevent any lateral movement of thrust restraints throughout pressure testing and operation.
7. Place 2500 psi concrete conforming to Section 03315 - Concrete for Utility Construction, for blocking at each change in direction of existing water lines, to brace pipe against undisturbed trench walls. Finish placement of concrete blocking, made from Type I cement, 4 days prior to hydrostatic testing of pipeline. Test may be made 2 days after completion of blocking if Type II cement is used.

F. Joint Grout (Concrete Cylinder Pipe, Bar Wrapped Pipe, Steel Pipe):

1. Mix cement grout mixture by machine except when less than 1/2 cubic yard is required. When less than 1/2 cubic yard is required, grout may be hand mixed. Mix grout only in quantities for immediate use. Place grout within 20 minutes after mixing. Discard grout that has set. Retempering of grout by any means is not permitted.
2. Prepare grout in small batches to prevent stiffening before it is used. Do not use grout which has become so stiff that proper placement cannot be assured without

- retempering. Use grout for filling grooves of such consistency that it will adhere to ends of pipe.
3. Surface Preparation: Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces with wire brush or hammer to sound, clean surface. Remove rust and foreign materials from metal surfaces in contact with grout.
 4. Follow established procedures for hot and cold weather concrete placement.
 5. Complete joint grout operations and backfilling of pipe trenches as closely as practical to pipe laying operations. Allow grouted exterior joints to cure at least 1 hour before compacting backfill.
 6. Grouting exterior joint space: Hold wrapper in place on both sides of joint with minimum 5/8-inch-wide steel straps or bands. Place no additional bedding or backfill material on either side of pipe until after grout band is filled and grout has mechanically stiffened. Pull ends of wrapper together at top of pipe to form access hole. Pour grout down one side of pipe until it rises on other side. Rod or puddle grout to ensure complete filling of joint recess. Agitate for 15 minutes to allow excess water to seep through joint band. When necessary, add more grout to fill joint completely. Protect gap at top of joint band from backfill by allowing grout to stiffen or by covering with structurally protective material. Do not remove band from joint. Proceed with placement of additional bedding and backfill material.
 7. Interior Joints for Pipe 24 inches and Smaller: Circumferentially butter bell with grout prior to insertion of spigot, strike off flush surplus grout inside pipe by pulling filled burlap bag or inflated ball through pipe with rope. After joint is engaged, finish off joint grout smooth and clean. Use swab approved by Project Manager for 20-inch pipe and smaller.
 8. Protect exposed interior surfaces of steel joint bands by metallizing, by other approved coatings, or by pointing with grout. Joint pointing may be omitted on potable water pipelines if joint bands are protected by zinc metallizing or other approved protective coatings.
 9. Remove and replace improperly cured or otherwise defective grout.
 10. Strike off grout on interior joints and make smooth with inside diameter of pipe.
 11. When installed in tunnel or encasement pipe and clearance within casing does not permit outside grout to be placed in normal manner, apply approved flexible sealer, such as Flex Protex or equal, to outside joint prior to joint engagement. Clean and prime surfaces receiving sealer in accordance with manufacturer's recommendations. Apply sufficient quantities of sealer to assure complete protection of steel in joint area. Fill interior of joint with grout in normal manner after joint closure.

12. Interior Joints for Water Lines 30 inches and Larger: Clean joint space, wet joint surfaces, fill with stiff grout and trowel smooth and flush with inside surfaces of pipe using steel trowel so that surface is smooth. Accomplish grouting at end of each work day. Obtain written acceptance from Project Manager of inside joints before proceeding with next day's pipe laying operation. During inspection, insure no delamination of joint mortar has occurred by striking joint mortar lining with rubber mallet. Remove and replace delaminated mortar lining.
 13. Work which requires heavy equipment to be over water line must be completed before mortar is applied to interior joints.
- G. Large Diameter Water Main Joint Testing: In addition to testing individual joints with feeler gauge approximately 1/2 inch wide and 0.015-inch thick, use other joint testing procedure approved or recommended by pipe manufacturer which will help ensure watertight installation prior to backfilling. Perform tests at no additional cost to City.
- H. Make curves and bends by deflecting joints or other method as recommended by manufacturer and approved by Project Manager. Submit details of other methods of providing curves and bends which exceed manufacturer's recommended deflection prior to installation.
1. Deflection of pipe joints shall not exceed maximum deflection recommended by pipe manufacturer, unless otherwise indicated on Drawings.
 2. If deflection exceeds that specified but is less than 5 percent, repair entire deflected pipe section such that maximum deflection allowed is not exceeded.
 3. If deflection is equal to or exceeds 5 percent from that specified, remove entire portion of deflected pipe section and install new pipe.
 4. Replace, repair, or reapply coatings and linings as required.
 5. Assessment of deflection may be measured by Project Manager at location along pipe. Arithmetical averages of deflection or similar average measurement methods will not be deemed as meeting intent of standard.
 6. When rubber gasketed pipe is laid on curve, join pipe in straight alignment and then deflect to curved alignment.
- I. Closures Sections and Approved Field Modifications to Steel, Concrete Cylinder Pipe, Bar Wrapped Pipe and Fittings:
1. Apply welded-wire fabric reinforcement to interior and exterior of exposed interior and exterior surfaces greater than 6 inches in diameter. Welded-wire fabric: minimum W1; maximum spacing 2 inches by 4 inches; 3/8 inch from surface of steel plate or middle third of lining or coating thickness for mortar thickness less than 3/4 inch.

2. Fill exposed interior and exterior surfaces with nonshrink grout.
3. For pipe diameters 36 inches and greater, perform field welds on interior and exterior of pipe.
4. For large diameter water lines, provide minimum overlap of 4 inches of butt strap over adjacent piece on butt-strap closures.

3.07 CATHODIC PROTECTION APPURTENANCES

- A. Where identified on Drawings, modify pipe for cathodic protection as detailed on Drawings and specified. Unless otherwise noted, provide insulation kits including test stations at connections to existing water system or at locations to isolate one type of cathodic system from another type, between water line, access manhole piping and other major openings in water line, or as shown on Drawings.
- B. Bond joints for pipe installed in tunnel or open cut, except where insulating flanges are provided. Weld strap or clip between bell and spigot of each joint or as shown on Drawings. No additional bonding required where joints are welded for thrust restraint. Repair coatings as specified by appropriate AWWA standard, as recommended by manufacturer, and as approved by Project Manager.
- C. Bonding Strap or Clip: Free of foreign material that may increase contact resistance between wire and strap or clip.

3.08 SECURING, SUPPORTING AND ANCHORING

- A. Support piping as shown on Drawings and as specified in this Section, to maintain line and grade and prevent transfer of stress to adjacent structures.
- B. Where shown on Drawings, anchor pipe fittings and bends installed on water line by welding consecutive joints of pipe together to distance each side of fitting. Restrained length, as shown on Drawings, assumes that installation of pipe and subsequent hydrostatic testing begins upstream and proceed downstream, with respect to normal flow of water in pipe. If installation and testing differs from this assumption, submit for approval revised method of restraining pipe joints upstream and downstream of device used to test against (block valve, blind flange or dished head plug).
- C. Use adequate temporary blocking of fittings when making connections to distribution system and during hydrostatic tests. Use sufficient anchorage and blocking to resist stresses and forces encountered while tapping existing water line.

3.09 POLYETHYLENE WRAP FOR DUCTILE IRON PIPE

- A. Double wrap pipe and appurtenances (except fire hydrants and fusion bond or polyurethane coated fittings) with 8-mil polyethylene film.
- B. Do not use polyethylene wrap if pipe is cathodically protected.
- C. Conform to requirements of Section 02528 - Polyethylene Wrap.

3.10 CLEANUP AND RESTORATION

- A. Provide cleanup and restoration crews to work closely behind pipe laying crews, and where necessary, during disinfection and hydrostatic testing, service transfers, abandonment of old water lines, backfill and surface restoration.
- B. Unless otherwise approved by Project Manager, comply with the following;
 - 1. Once water line is installed to limits approved in layout submitted, immediately begin preparatory work for disinfection effort.
 - 2. No later than three days after completing disinfection preparatory work, submit to City appropriate request for disinfection.
 - 3. If City fails to perform initial disinfection of lines in accordance with Section 2514 - Disinfection of Water Lines, within seven days from submission of appropriate request, and if approved by Project Manager, pipe laying operations may continue beyond approved limits until the City responds.
 - 4. Immediately after transfer of services, begin abandonment of old water lines and site restoration.
 - 5. Do not exceed a total of 50% of total project linear feet of disturbed right-of-way and easement until site is restored in accordance with Section 01740 - Site Restoration.
 - 6. Exceeding any of the above footage limitations shall be considered a material breach of the Contract and subject to termination in accordance with the General Conditions.
- C. For large diameter water lines, do not install more than 2,000 linear feet of water line, without previous 2,000 linear feet being restored in accordance with Section 01740 - Site Restoration. Schedule paving crews so repaving work will not lag behind pipe laying work by more than 1,000 linear feet. Failure to comply with this requirement shall be considered a material breach of the Contract and subject to termination in accordance with the General Conditions.

3.11 CLEANING PIPING SYSTEMS

- A. Remove construction debris or foreign material and thoroughly broom clean and flush piping systems. Provide temporary connections, equipment and labor for cleaning. City must inspect water line for cleanliness prior to filling.

3.12 DISINFECTION OF WATER LINES

- A. Conform to requirements of Section 02514 - Disinfection of Water Lines.

3.13 FIELD HYDROSTATIC TESTS

- A. Conform to requirements of Section 02515 - Hydrostatic Testing of Pipelines.

END OF SECTION

Section 02512

WATER TAP AND SERVICE LINE INSTALLATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tapping existing mains and furnishing and installing new service lines for water.
- B. Relocation of existing small water meters.
- C. Specifications identify requirements for both small-diameter (less than or equal to 20 inches) water lines and large-diameter (greater than 20 inches) water lines. When specifications for large-diameter water lines differ from those for small-diameter water lines, paragraphs for large-diameter water lines will govern for large-diameter pipe.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for water taps and copper service lines 3/4 inch through 1 inch is on unit price basis for each installation. Separate measurements will be made for "short side", "long side" and "extra long side" connections as defined in Paragraph 1.04, Definitions.
 - 2. Payment for water taps and service lines 1 1/2 inch through 2 inch is on unit price basis for each installation. Separate measurements will be made for "short side", "long side" and "extra long side" connections as defined in Paragraph 1.04, Definitions.
 - 3. Payment for "short side", "long side" and "extra long side" includes locating water line, tap installation and connection to meter and restoring site.
 - 4. Payment for each small meter includes labor, materials, and equipment to relocate existing small meter.
 - 5. No additional payment will be made for bedding, backfill, compaction, push under pavement, etc.
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. AWWA C 800 - Standard for Underground Service Line Valves and Fittings.
- B. AWWA C 900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in., for Water Distribution.

1.04 DEFINITIONS

- A. Short Side Connection: Service line connecting proposed curb stop, located inside water meter box, to water line on same side of street.
- B. Long Side Connection: Service line connecting proposed curb stop, located inside water meter box, to water line on opposite side of street or from center of streets where supply line is located in street center such as boulevards and streets with esplanades. Distance not to exceed 60 linear feet (at right angles to water line).
- C. Extra Long Side Connection: Service line connecting proposed curb stop, located inside water meter box, to water line on opposite side of street or from center of streets where supply line is located in street center such as boulevards and streets with esplanades. Distance greater than 60 linear feet (at right angles to water line).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Copper Tubing: In accordance with Section 02503 - Copper Tubing. Polybutylene tubing is not permitted.
- B. Corporation Stops: AWWA C 800 as modified in this Section:
 - 1. Inlet End: AWWA standard thread.
 - 2. Valve Body: Tapered plug type, O-ring seat ball type, or rubber seat ball type.
 - 3. Outlet End: Flared-copper connection for use with Type K, soft copper or compression type fitting.
- C. Provide taps for water line types and sizes in accordance with pipe tapping schedule located at end of this Section.
- D. Dual Strap Saddles: Red brass body and straps; ductile-iron; vinyl-coated body and straps; or ductile-iron, vinyl-coated body and stainless-steel straps.

- E. Taps for PVC Water Lines: Use dual-strap or single, wide-band strap saddles which provide full support around circumference of pipe and bearing area of sufficient width along axis of pipe, 2 inches minimum, ensuring that pipe will not be distorted when saddle is tightened. Provide approved stainless-steel tapping saddle with AWWA standard thread .
- F. Taps for Steel Pipe: Not allowed, unless specifically approved by Project Manager. Use saddle only when tap is approved on steel pipe.
- G. Curb Stops and Brass Fittings: AWWA C 800 as modified in this Section.
1. Inlet End: Flared copper connection or compression-type fitting
 2. Valve Body: Straight-through or angled, meter-stop design equipped with following:
 - a. O-ring seal straight plug type.
 - b. Rubber seat ball type.
 3. Outlet End: Female, iron-pipe thread or swivel-nut, meter-spud thread on 3/4-inch and 1-inch stops and 2-hole flange on 1 1/2 and 2-inch sizes.
 4. Fittings: Provide approved fittings. Use same size open end wrenches and tapping machines as used with respective Mueller fittings.
 5. Factory Testing of Brass Fittings:
 - a. Submerge in water for 10 seconds at 85 psi with stop in both closed and open positions.
 - b. Reject fitting that shows air leakage. Project Manager may confirm tests locally. Entire lot from which samples were taken will be rejected when random sampling discloses unsatisfactory fittings.
- H. Angle Stops: In accordance with AWWA C 800; ground-key, stop type with bronze lock-wing head stop cap; inlet and outlet threads conform to application tables of AWWA C 800; and inlets flared connection or compression.
1. Outlet for 3/4-inch and 1-inch size: Meter swivel nut with saddle support.
 2. Outlet for 1 1/2-inch through 2-inch size: O-ring sealed meter flange, iron pipe threads.
- I. Fittings: In accordance with AWWA C 800 and following:
1. Castings: Smooth, free from burrs, scales, blisters, sand holes, and defects which would make them unfit for intended use.

2. Nuts: Smooth cast and has symmetrical hexagonal wrench flats.
3. Flare-Joint Fittings: Smooth cast. Machine seating surfaces for metal-to-metal seal to proper taper or curve, free from pits or protrusions.
4. Thread fittings, of all types, shall have N.P.T. or AWWA threads, and protect male threaded ends in shipment by plastic coating, or approved equal.
5. Compression tube fittings shall have Buna-N beveled gasket.
6. Stamp of manufacturer's name or trademark and of fitting size on body.

PART 3 EXECUTION

3.01 GENERAL

- A. For service lines and lateral connections larger than those allowed in Pipe Tapping Schedule, branch connections and multiple taps may be used. Space corporation stops minimum of 2 feet apart.
- B. Tapped collars of appropriate sizes: Approved in new construction only provided they are set at right angles to proposed meter location.
- C. Use tapping machine manufactured for pressure tapping purposes for 2-inch and smaller service taps on pressurized water lines.
- D. For new meter or when existing meter is in conflict with proposed pavement improvements, locate water meters one foot inside street right-of-way, or when this is not feasible, one foot on curb side of sidewalk. Contact Project Manager when major landscaping or trees conflict with service line and meter box location. No additional payment will be made for work on customer side of meter.
- E. New location and installation of existing small meter shall conform to requirements of this Section.

3.02 SERVICE INSTALLATION

- A. Set service taps at right angles to proposed meter location and locate taps in upper pipe segment within 45 degrees of pipe springline.
- B. Install service lines in open-cut trench in accordance with Section 02317 - Excavation and Backfill for Utilities. Install service lines under paved roadways, other paved areas and areas indicated on Drawings in bored hole in accordance with Paragraph 3.01G.

- C. Lay service lines with minimum of 30 inches of cover as measured from top of curb or, in absence of curbs, from centerline elevation of crowned streets or roads. Provide minimum of 18 inches of cover below flow line of ditches to service lines.
- D. Service lines across existing street (push-unders): Pull service line through prepared hole under paving. Use only full lengths of tubing. Take care not to damage copper tubing when pulling it through hole. Compression-type union is only permitted when span underneath pavement cannot be accomplished with a full standard length of tubing. Use one compression-type union for each full length of tubing.
- E. Maintain service lines free of dirt and foreign matter.
- F. Install service lines so that top of meter will be 4 to 6 inches below finished grade.
- G. Anticipate existing sanitary sewers to have cement stabilized sand backfill to bottom of pavement. Include cost of such crossings in unit price for services.

3.03 CURB STOP INSTALLATION

- A. Set curb stops or angle stops at outer end of service line inside of meter box. Secure opening in curb stop to prevent unwanted material from entering. In close quarters, make S-curve in field. Do not flatten tube. In 3/4-inch and 1-inch services, install meter coupling, swivel-nut, or curb stop ahead of meter. Install straight meter coupling on outlet end of meter.

3.04 SEQUENCE OF OPERATIONS

- A. Open trench for proposed service line in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Install curb stop on meter end of service line.
- C. With curb stop open and prior to connecting service line to meter in slack position, open corporation stop and flush service line thoroughly. Close curb stop, leaving corporation stop in full-open position.
- D. Check service line for apparent leaks. Repair leaks before proceeding.
- E. Schedule inspection with Project Manager prior to backfilling. After inspection, backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.
- F. Install meter box centered over meter with top of lid flush with finished grade. Meter box: Refer to Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.

END OF SECTION

Table 02512-1

PIPE TAPPING SCHEDULE				
WATERLINE TYPE AND DIAMETER	SERVICE SIZE			
	3/4"	1"	1-1/2"	2"
4" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
4" Asbestos Cement	WBSS	WBSS	DSS, WBSS	DSS, WBSS
4" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" Asbestos Cement	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
6" and 8" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
12" Cast Iron or Ductile Iron	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
12" Asbestos Cement	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
12" PVC (AWWA C900)	DSS, WBSS	DSS, WBSS	DSS, WBSS	DSS, WBSS
16" and Up Cast Iron or Ductile Iron	DWBSS	DWBSS	DWBSS	DWBSS
16" and Up Asbestos Cement	DWBSS	DWBSS	DWBSS	DWBSS
16" and Up PVC (AWWA C900)	DWBSS	DWBSS	DWBSS	DWBSS

DSS - DUAL STRAP SADDLES
WBSS - WIDE BAND STRAP SADDLES
DWBSS - DUAL WIDE BAND STRAP SADDLES

Section 02513

WET CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wet connections for new water lines and service lines to existing water lines.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for wet connections shown on Drawings is on unit price basis for each wet connection. Separate payment will be made for each size of water line.
 - 2. No compensation will be given for extra work or for damages occurring as result of incomplete shutoff.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. AWWA C 800 - Standard for Underground Service Line Valves and Fittings.

1.04 DEFINITIONS

- A. Wet connections consist of isolating sections of pipe to be connected with existing valves, draining isolated sections, and completing connections.
- B. Connection of 2-inch or smaller lines, which may be referred to on Drawings as "2-inch standard connections" or "gooseneck connections" will be measured as 2-inch wet connections. This item is not to be used as part of 2-inch service line.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Pipe shall conform to requirements of applicable portions of Sections 02501 through 02528 related to piping materials and to water distribution.
- B. Corporation cocks and saddles shall conform to requirements of Section 02512 - Water Tap and Service Line Installation.
- C. Valves shall conform to requirements of Section 02521 - Gate Valves.
- D. Brass fittings shall conform to requirements of AWWA C 800.

PART 3 E X E C U T I O N

3.01 CONNECTION OPERATIONS

- A. Plan wet connections in manner and at hours with least inconvenience public. Notify Project Manager at least 72 hours in advance of making connections.
- B. Do not operate valves on water lines in use by City. City of Houston Utility Operations Division will handle, at no cost to Contractor, operations involving opening and closing valves for wet connections.
- C. Conduct connection operations when Inspector is at job site. Connection work shall progress without interruption until complete once existing water lines have been cut or plugs have been removed for making connections.

3.02 2-INCH WET CONNECTIONS

- A. Tap water line. Use corporation cocks, saddles, copper tubing as required for line and grade adjustment, and brass fittings necessary to adapt to existing water line. Use 2-inch valves when indicated on Drawings for 2-inch copper gooseneck connections.

END OF SECTION

Section 02514

DISINFECTION OF WATER LINES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disinfection of potable water lines.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

- 1. No separate payment will be made for disinfection of water lines under this Section. Include cost in unit price of water lines being disinfected.
- 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Adjusting Payment for Retesting.

- 1. Subsequent disinfection operations which may be necessary due to nonconforming or incomplete construction will be charged to Contractor. Charges will be deducted from retainage amounts when construction estimates are processed for final payment.
- 2. Total charge will consist of base charge of \$135.00 plus footage charge based on number of feet of specified diameter pipe in construction project. Footage charge is as follows:

<u>Size of Pipe</u>	<u>Charge per Linear Foot</u>
2 inch to 4 inch	\$0.03
6 inch	\$0.04
8 inch	\$0.05
10 inch to 12 inch	\$0.07
16 inch to 20 inch	\$0.09
24 inch to 30 inch	\$0.13
32 inch to 48 inch	\$0.16
54 inch	\$0.20
60 inch	\$0.22
66 inch	\$0.31
72 inch to 84 inch	\$0.40
90 inch to 96 inch	\$0.58
108 inch	\$0.75
120 inch or larger	\$1.00

- C. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. AWWA C 651 - Standard for Disinfecting Water Mains.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.01 CONDUCTING DISINFECTION

- A. Promptly disinfect water lines constructed before tests are conducted on water lines and before water lines are connected to City water distribution system.
- B. Water for disinfection and flushing will be furnished by City without charge.
- C. Unless otherwise provided in Contract Documents, City will conduct disinfection operations assisted by Contractor.
- D. Coordinate chlorination operations through Project Manager.

3.02 PREPARATION

- A. Provide temporary blind flanges, cast-iron sleeves, plugs, necessary service taps, copper service leads, risers and jumpers of sizes, location and materials, and other items needed to facilitate disinfection of new water lines prior to connection to City water distribution system. Normally, each valved section of water line requires two each 3/4-inch taps. A 2-inch minimum blow-off is required for water lines up to and including 6-inch diameter.
- B. Use fire hydrants as blow-offs to flush newly constructed water lines 8 inch diameters and above. Where fire hydrants are not available on water lines, install temporary blow-off valves and remove promptly upon successful completion of disinfection and testing.
- C. Slowly fill each section of pipe with water in manner approved by Project Manager. Average water velocity when filling pipeline should be less than one foot per second and shall not, under any circumstance, exceed 2 feet per second. Before beginning disinfection operations, expel air from pipeline.
- D. Backfill excavations immediately after installation of risers or blow-offs.

- E. Install blow-off valves at end of water line to facilitate flushing of dead-end water lines. Install permanent blow-off valves according to drawings.

3.03 DISINFECTION BY CITY PERSONNEL

- A. Correct problems that may prevent disinfection operations prior to advising Project Manager to perform disinfection work. When disinfection work cannot be performed due to covered up valves, missing valve stacks, inoperative fire hydrants or other nonconforming construction, charge will be levied against Contractor for each trip made by City personnel.
- B. Notify and coordinate with Project Manager minimum of 72 hours before disinfection work is to be performed. Assist City personnel during disinfection operations.

3.04 DISINFECTION BY CONTRACTOR

- A. The following procedure will be used when disinfection by Contractor is required by Contract Documents:
 - 1. Use not less than 100 parts of chlorine per million parts of water.
 - 2. Introduce chlorinating material to water lines in accordance with AWWA C 651.
 - 3. After contact period of not less than 24 hours, flush system with clean water until residual chlorine is no greater than 1.0 parts per million parts of water.
 - 4. Open and close valves in lines being sterilized several times during contact period.
 - 5. If chemical compound is used for sterilizing agent, place in pipes as directed by Project Manager.

3.03 BACTERIOLOGICAL TESTING

- A. After disinfection and flushing of water lines, bacteriological tests will be performed by City or testing laboratory in accordance with Section 01454 - Testing Laboratory Services. When test results indicate need for additional disinfection of water lines based upon Texas Department of Health requirements, assist City with additional disinfection operations.

3.06 COMPLETION

- A. Upon completion of disinfection and testing, remove risers except those approved for use in subsequent hydrostatic testing, and backfill excavation promptly.

END OF SECTION

Section 02516

CUT, PLUG AND ABANDONMENT OF WATER LINES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cut, plug and abandonment of water lines.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for cut, plug, and abandonment of water lines is on a unit price basis for each cut, plug, and abandonment performed. Separate payment will be made for each size of water line.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for proposed plugs and clamps for approval.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete for reaction blocks: Class B conforming to requirements of Section 03315 - Concrete for Utility Construction.
- B. Plugs and clamps: Applicable for type of pipe to be plugged.

PART 3 EXECUTION

3.01 APPLICATION

- A. Do not begin cut, plug and abandonment operations until replacement water line has been constructed, disinfected, and tested, and service lines have been transferred to replacement water line.
- B. Install plug, clamp, and concrete reaction block and make cut at location shown on Drawings.
- C. Main to be abandoned shall not be valved off and shall not be cut or plugged other than at supply water line or as shown on Drawings.
- D. After water line to be abandoned has been cut and plugged, check for other sources feeding abandoned water line. When sources are found, notify Project Manager immediately. Cut and plug abandoned water line at point of other feed as directed by Project Manager.
- E. Plug or cap ends or openings in abandoned water line in manner approved by Project Manager.
- F. Remove and dispose of surface identifications such as valve boxes and fire hydrants. Valve boxes in improved streets, other than shell, may be filled with concrete after removing cap.
- G. Backfill excavations in accordance with Section 02317 - Excavation and Backfill for Utilities.
- H. Repair street surfaces in accordance with Section 02951- Pavement Repair and Resurfacing.

END OF SECTION

Section 02521

GATE VALVES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Gate valves.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. No separate payment will be made for gate valves 20 inches in diameter and smaller under this Section. Include payment in unit price for water lines.
2. Payment for gate valves 24 inches to 36 inches in diameter is on a unit price basis. Unit price includes cost of required box for gate valves.
3. Payment for 2-inch blow-off valve with box is on a unit price basis for each installation.
4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- B. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Casting.
- C. ASTM D 429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
- D. ASTM B 763 - Standard Specification for Copper Alloy Sand Casting for Valve Application.
- E. AWWA C 500 - Standard for Metal-Seated Gate Valves for Water Supply Service.
- F. AWWA C 509 - Standard for Resilient-Seated Gate Valves for Water Supply Service.
- G. AWWA C 515- Standard for Reduced Wall, Resilient- Seated Gate Valves for Water Supply Service.

- H. AWWA C 550 - Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's product data for proposed valves for approval.
- D. Provide detailed drawings of gearing mechanism for 20-inch and larger gate valves.

1.05 QUALITY CONTROL

- A. Submit manufacturer's affidavit that gate valves are manufactured in the United States and conform to stated requirements of AWWA C 500, AWWA C 509, AWWA C 515, and this Section, and that they have been satisfactorily tested in the United States in accordance with AWWA C 500, AWWA C 509, and AWWA C 515.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Gate Valves: AWWA C 500, AWWA C 509, AWWA C 515 and additional requirements of this Section. Direct bury valves and those in subsurface vaults open clockwise; aboveground and plant valves open counterclockwise.
- B. If type of valve is not indicated on Drawings, use gate valves as line valves for sizes 20-inches and smaller. When type of valve is indicated, no substitute is allowed.
- C. Gate Valves 1-1/2 inches in Diameter and Smaller: 125 psig; bronze; rising-stem; single-wedge; disc type; screwed ends
- D. Coatings for Gate Valves 2 inches and larger: AWWA C 550 non-toxic, imparts no taste to water, functions as physical, chemical, and electrical barrier between base metal and surroundings, minimum 8-mil-thick, fusion-bonded epoxy. Prior to assembly of valve, apply protective coating to interior and exterior surfaces of body.
- E. Gate Valves 2 inches in diameter: Iron body, double disc or resilient-seated, non-rising stem, 150-pound test, 2-inch square nut operating clockwise to open.
- F. Gate Valves 3 inches to 12 inches in diameter: Non-directional, standard-wall resilient seated (AWWA C 509), parallel seat double disc (AWWA C 500), or reduced-wall resilient seated gate valves (AWWA C 515), 200 psig pressure rating, bronze mounting, push-on bell ends with rubber joint rings, and nut-operated unless otherwise specified. Provide approved standard-wall resilient seated valves. Provide approved reduced-wall resilient seated valves.

Provide approved double disc valves. Comply with following requirements unless otherwise specified in Drawings:

1. Design: Fully encapsulated rubber wedge or rubber seat ring mechanically attached with minimum 304 stainless-steel fasteners or screws; threaded connection isolated from water by compressed rubber around opening.
 2. Body: Cast or ductile iron, flange bonnet and stuffing box together with ASTM A 307 Grade B bolts. Manufacturer's initials, pressure rating, and year manufactured shall be cast in body.
 3. Bronze: Valve components in waterway to contain not more than 15 percent zinc and not more than 2 percent aluminum.
 4. Stems: ASTM B 763 bronze, alloy number-995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.
 5. O-rings: For AWWA C 500, Section 3.12.2. For AWWA C 509, Sections 2.2.6 and 4.8.2. For AWWA C 515, Section 4.2.2.5.
 6. Stem Seals Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar for operating torque.
 - G. Stem Nut: Independent or integrally cast of ASTM B 62 bronze.
 - H. Resilient Wedge: Molded, synthetic rubber, vulcanized and bonded to cast or ductile iron wedge or attached with 304 stainless steel screws tested to meet or exceed ASTM D 429 Method B; seat against epoxy-coated surface in valve body.
 - I. Bolts: AWWA C 500 Section 3.4, AWWA C 509 Section 4.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.
- G. Gate valves 14 inch and larger in Diameter: AWWA C 500; parallel seat double disc gate valves; push-on bell ends with rubber rings and nut-operated unless otherwise specified. Provide approved double disc valves with 150 psig pressure rating. Comply with following requirements unless otherwise specified on Drawings:
1. Body: Cast iron or ductile iron; flange together bonnet and stuffing box with ASTM A 307 Grade B bolts. Cast following into valve body manufacturer's initials, pressure rating, and year manufactured. When horizontally mounted, equip valves greater in diameter than 12 inches with rollers, tracks, and scrapers.
 2. O rings: For AWWA C 500, Section 3.12.2. For AWWA C 515, Section 4.2.2.5.

3. Stems: ASTM B 763 bronze, alloy number-995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.
 4. Stem Nut: Machined from ASTM B 62 bronze rod with integral forged thrust collar machined to size; non-rising.
 5. Stem Seals: Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar for operating torque.
 6. Bolts: AWWA C 500 Section 3.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.
 7. Discs: Cast iron with bronze disc rings securely panned into machined dovetailed grooves.
 8. Wedging Device: Solid bronze or cast-iron, bronze-mounted wedges. Thin plates or shapes integrally cast into cast-iron surfaces are acceptable. Other moving surfaces integral to wedging action shall be bronze monel or nickel alloy-to-iron.
 9. Provide bypass for valves 24 inches and larger.
 10. Bronze Mounting: Built as integral unit mounted over, or supported on, cast-iron base and of sufficient dimensions to be structurally sound and adequate for imposed forces.
 11. Gear Cases: Cast iron; furnished on 18-inch and larger valves and of extended type with steel side plates, lubricated, gear case enclosed with oil seal or O-rings at shaft openings.
 12. Stuffing Boxes: Located on top of bonnet and outside gear case.
- H. Gate valves 14 inches to 24 inches: Provide AWWA C 515; reduced-wall, resilient seated gate valves with 250 psig pressure rating. Furnish with spur or bevel gearing.
1. Mount valves horizontally if proper ground clearance cannot be achieved by normal vertical installation. For horizontally mounted gate valves, provide bevel operation gear mounted vertically for above ground operation.
 2. Use valve body, bonnet, wedge, and operator nut constructed of ductile iron. Fully encapsulate exterior of ductile iron wedge with rubber.
 3. Ensure wedge is symmetrical and seals equally well with flow in either direction.
 4. Provide ductile iron operator nut with four flats at stem connection to apply even input torque to the stem.

5. Bolts: AWWA C515, Section 4.4.4, Stainless Steel; cadmium plated or zinc coated.
 6. Provide high strength bronze stem and nut.
 7. O-rings: AWWA C515, Section 4.2.2.5, pressure O-rings as gaskets.
 8. Provide stem sealed by three O-rings. Top two O-rings are to be replaceable with valve fully open at full rated working pressure.
 9. Provide thrust washers to the thrust collar for easy valve operation.
- K. Gate Valves Extension Stem: When shown on Drawings, provide non-rising, extension stem having coupling sufficient to attach securely to operating nut of valve. Upper end of extension stem shall terminate in square wrench nut no deeper than 4 feet from finished grade or as shown on Drawings. Support extension stem with an arm attached to wall of manhole or structure that loosely holds extension stem and allows rotation in the axial direction only.
- L. Gate Valves in Factory Mutual (Fire Service) Type Meter Installations: Conform to provisions of this specification; outside screw and yoke valves; carry label of Underwriters' Laboratories, Inc.; flanged, Class 125; clockwise to close.
- M. Gate Valves for Tapping Steel Pipe: Provide double disc gate valve. Resilient wedge gate valve shall only be installed in a vertical position.
- N. Provide flanged joints when valve is connected to steel or PCCP.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Earthwork. Conform to applicable provisions of Section 02317 - Excavation and Backfilling for Utilities.
- B. Operation. Do not use valves for throttling without prior approval of manufacturer.

3.02 SETTING VALVES AND VALVE BOXES

- A. Remove foreign matter from within valves prior to installation. Inspect valves in open and closed positions to verify that parts are in satisfactory working condition.
- B. Install valves and valve boxes where shown on Drawings. Set valves plumb and as detailed. Center valve boxes on valves. Carefully tamp earth around each valve box for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet. Install valves completely closed when placed in water line.

- C. For pipe section of each riser, use only 6 inch, ductile iron Class 51, or DR18 PVC pipe cut to proper length. Riser must be installed to allow complete access for operation of valve. Assemble and brace box in vertical position as indicated on Drawings.

3.03 DISINFECTION AND TESTING

- A. Assist Project Manager with disinfection of valves and appurtenances as required by Section 02514 - Disinfection of Water Lines and test as required by Section 02515 - Hydrostatic Testing of Pipelines.
- B. Double-Disc Gate Valves: Apply hydrostatic test pressure equal to twice rated working pressure of valve between discs. Valve shall show no leakage through metal, flanged joints, or stem seals. Test at rated working pressure, applied between discs. Valve shall show no leakage through metal, flanged joints, or stem seals. Do not exceed leakage rate of 1 oz/hr/inch of nominal valve size.
- C. Solid-Wedge Gate Valves: Apply hydrostatic pressure equal to twice rated working pressure of valve with both ends bulkheaded and gate open. Valve shall show no leakage through metal, flanged joints, or stem seals. Test at rated working pressure, applied through bulkheads alternately to each side of closed gate with opposite side open for inspection. Valve shall show no leakage through metal, flanged joints, or stem-seals. Do not exceed leakage rate of 1 oz/hr/inch of nominal valve size.
- D. Repair or replace valves which exceed leakage rate.

3.04 PAINTING OF VALVES

- A. Paint valves in vaults, stations, and above ground with approved paint.

END OF SECTION

Section 02525

TAPPING SLEEVES AND VALVES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tapping sleeves and valves for connections to existing water system.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment is on unit price basis for each tap installed.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
 - 3. For water lines 4-inches and greater, no payment will be made until coupon (cut out portion of pipe tapped) is delivered to City.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
- B. ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
- C. ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service
- D. AWWA C 110 - Standard for Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and other Liquids.
- E. AWWA C 200 - Standard for Steel Water Pipe - 6 in. and Larger.
- F. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in.
- G. AWWA C 500 - Standard for Metal Seated Gate Valves, for Water Supply Service.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit results of tapping sleeves NPT test opening.
- C. Submit manufacturer's affidavit as required in Section 02521 - Gate Valves.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Ship steel sleeves in wooden crates that provide protection from damage to epoxy coating during transport and storage.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Tapping Sleeves:
 - 1. Tapping Sleeve Bodies: AWWA C 110 cast or ductile iron or AWWA C 200 carbon steel in two sections to be bolted together with high-strength, corrosion-resistant, low-alloy steel bolts with mechanical joint ends.
 - 2. Branch Outlet of Tapping Sleeve:
 - a. Flanged, machined recess, AWWA C 207, Class D, ANSI 150 pound drilling.
 - b. Gasket: Affixed around recess of tap opening to prevent rolling or binding during installation.
 - 3. Use cast iron split sleeve where fire service from 6-inch water line is approved.
- B. Welded-steel tapping-sleeve bodies may be used in lieu of cast or ductile iron bodies for following sizes and with following restrictions:
 - 1. Flange: AWWA C 207, Class D, ANSI 150 pound drilling.
 - 2. Gasket: Affixed around recess of tap opening to prevent rolling or binding during installation.
 - 3. Steel sleeves are restricted to use on pipe sizes 6 inches and larger.
 - 4. Body: Heavy, welded-steel construction; top half grooved to retain neoprene O-ring seal permanently against outside diameter of pipe.

5. Bolts: AWWA C 500 Section 3.5; coated with 100 percent vinyl resin or corrosive resistant material.
 6. Steel Sleeves Finish: Fusion-bonded epoxy coated to minimum 12 mil thickness.
 7. Finished Epoxy Coat: Free of laminations and blisters; and remain pliant and resistant to impact with non-peel finish.
 8. Provide approved steel tapping sleeves
 9. Tapping Sleeves: Provide with 3/4-inch NPT test opening for testing prior to tapping. Provide 3/4-inch bronze plug for opening.
 10. Do not use steel sleeves for taps greater than 75 percent of pipe diameter.
- C. Stainless Steel tapping-sleeve bodies and flange may be used in lieu of cast or ductile iron bodies for following sizes and with following restrictions:
1. Flange: ASTM A240 Stainless Steel, Type 304, ANSI 150 pound drilling.
 2. Gasket: Full circumferential, affixed around recess of tap opening to prevent rolling or binding during installation, compounded for water and sewer service.
 3. Stainless Steel sleeves are restricted to use on pipe sizes 4 inches and larger.
 4. Body: ASTM A240 Stainless Steel, Type 304.
 5. Bolts: ASTM A193 Stainless Steel, Type 304.
 6. Nuts: ASTM A194 Stainless Steel, Type 304
 7. Branch Outlet: Heavy Stainless Steel Pipe
 8. Provide approved stainless steel tapping sleeves.
 9. Do not use stainless steel sleeves for taps greater than 75 percent of pipe diameter.
- C. Tapping Valves: Meet requirements of Section 02521 - Gate Valves with following exceptions:
1. Inlet Flanges:
 - a. AWWA C 110; Class 125.
 - b. AWWA C 110; Class 150 and higher: Minimum 8-hole flange.

2. Outlet: Standard mechanical or push-on joint to fit any standard tapping machine.
 3. Valve Seat Opening: Accommodate full-size shell cutter for nominal size tap without contact with valve body; double disc.
- D. Valve Boxes: Standard Type "A" valve boxes conforming to requirements of Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.

PART 3 EXECUTION

3.01 APPLICATION

- A. Install tapping sleeves and valves at locations and of sizes shown on Drawings. Install sleeve so valve is in horizontally level position unless otherwise indicated on Drawings.
- B. Clean tapping sleeve, tapping valve, and pipe prior to installation and in accordance with manufacturer's instructions.
- C. Hydrostatically test installed tapping sleeve to 150 psig for minimum of 15 minutes. Inspect sleeve for leaks, and remedy leaks prior to tapping operation.
- D. When tapping concrete pressure pipe, size on size, use shell cutter one standard size smaller than water line being tapped.
- E. Do not use Large End Bell (LEB) increasers with next size tap unless existing pipe is asbestos-cement.

3.02 INSTALLATION

- A. Verify outside diameter of pipe to be tapped prior to ordering sleeve.
- B. Tighten bolts in proper sequence so that undue stress is not placed on pipe.
- C. Align tapping valve properly and attach to tapping sleeve. Insert insulation sleeves into flange holes of tapping valve and pipe. Make insertions of sleeves on pipe side of tapping valve. Do not damage insulation sleeves during bolt tightening process.
- D. Make tap with sharp, shell cutter:
 1. For 12-inch and smaller tap, use minimum cutter diameter one-half inch less than nominal tap size.
 2. For 16-inch and larger tap, use manufacturer's recommended cutter diameter.
- E. Withdraw coupon and flush cuttings from newly-made tap.

- F. Wrap:
 - 1. For 12-inch and smaller tap, wrap completed tapping sleeve and valve in accordance with Section 02528 - Polyethylene Wrap.
 - 2. For 16-inch and larger tap, apply coal tar epoxy around completed tapping sleeve and valve. The coal tar epoxy shall be applied with minimum of two (2) coats. Each coat of coal tar epoxy shall have minimum dry film thickness of 16 mils.
- G. Place concrete thrust block behind tapping sleeve (not over tapping sleeve and valve).
- H. Request inspection of installation prior to backfilling.
- I. Backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

Section 02526

WATER METERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water meters, submeters, and fire service meters.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

1. Measurement for water meters is on unit price basis for installation of each meter type and size.
2. Payment includes vault, piping and appurtenances necessary for complete installation of meter.
3. Measurement for relocating and reinstalling meter with new box is on unit price basis for each meter relocated and reinstalled.
4. No separate payment for adjustment of meter or meter box unless otherwise shown in Drawings.
5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work is in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASME B 16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
- B. AWWA C 510 - Standard for Double Check Valve Backflow - Prevention Assembly.
- C. AWWA C 700 - Standard for Cold-Water Meters - Displacement Type.
- D. AWWA C 701 - Standard for Cold-Water Meters - Turbine Type for Customer Service.
- E. AWWA C 702 - Standard for Cold-Water Meters - Compound Type.
- F. AWWA C 703 - Standard for Cold-Water Meters - Fire Service Type.

- G. AWWA Manual M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit written certification of calibration and test results.
- C. Submit manufacturer's certification that meters meet applicable requirements of this Specification Section.
- D. Submit accuracy registration test certification from manufacturer for each 3-inch through 10-inch diameter meter.

1.05 QUALITY CONTROL

- A. Submit manufacturer's warranty against defects in materials and workmanship for one year from date of Substantial Completion.
- B. Provide vendor's unconditional guarantee that performance of each meter meets applicable AWWA standards and AWWA Manual M6 as follows:

- 1. Displacement type: 10 years from installation or register registration shown below, whichever comes first.

Size (inch)	Registration (million gallons)
5/8, 3/4	1.5
1	2.5
1-1/2	5.0
2	10.5

- 2. Turbine type: 1 year from date of installation.
 - 3. Compound type: 1 year from date of installation.
 - 4. Fire service type: 1 year from date of installation.

Operations of hermetically sealed register, 5/8-inch to 2-inch diameter, shall be unconditionally guaranteed for 15 years.

- C. Provide manufacturer's unconditional guarantee for each sealed register against leakage, fogging, discoloration and stoppage for 15 years from date of installation.

- D. Vendor may replace meters that become defective within guarantee period with meters that comply with this Specification. City will return defective meters to vendor at expense. Meters repaired or replaced under this guarantee must meet accuracy limits for new meters upon receipt and accuracy limits for remaining period of initial guarantee.

1.06 EASEMENT REQUIREMENTS

- A. Install 2-inch and smaller water meters and shut-off valves (stop boxes) at right-of-way line when possible. Otherwise, install within 5 foot by 5 foot water meter easement.
- B. Except for 10-inch fire service compound water meters, install 3-inch and larger water meters within minimum of 10 foot by 20 foot water meter easement.
- C. Install 10-inch fire service proportional or compound water meters within minimum of 10-foot by 25-foot water meter easement.
- D. Locate water meter easements contiguous with public right-of-way unless approved by Project Manager. Provide minimum fifteen foot wide access easement when not contiguous with public right-of-way.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide meters of type and size as indicated on Drawings, unless otherwise indicated.
- B. Provide bolted split casings. Main casings of meters and external fasteners: Copper alloy with minimum 75 percent copper for 5/8 inch to 2 inches, bronze or cast iron, hot-dipped galvanized or epoxy coating for 3 inches and larger.
- C. Straightening Vanes: Non-corrosive material compatible with case material.
- D. Intermediate gear train shall not come into contact with water and shall operate in suitable lubricant.
- E. Registers: Automatic Meter Reading (AMR) type that provides pulse, contact closure, piezo switch or encoder generated output signal, compatible with City's radio and telephone AMR systems. Provide minimum 12-foot wire when permanently connected to register. Lens: impact resistant. Register box: tamper resistant by means of tamper screw or plug; Register: permanently sealed, straight-reading, center-sweep test hand, magnetic driven, U.S. gallons. Digits: 6, black in color, with lowest registering 3 digits (below 1,000-gallon registration) having contrasting digit and background color. Register capacity of meters: 9.99 million gallons for 5/8 inch to 2 inches and 999.999 million gallons for 3 inches and larger.

- F. Connections: 5/8 inch to 1 inch: threads at each end; 1-1/2 to 2 inches: 2-bolt oval flanges each end; 3 inches and larger: flange at each end.
- G. Stamp manufacturer's meter serial number on outer case. Stamp manufacturer's meter serial number on outside of register lid when provided. Manufacturer's serial numbers shall be individual and not duplicated.
- H. Meters: Provide approved meters equip with AMR type register to connect to City of Houston's AMR system.
- I. Manufacturing Quality Control shall permit successful interchangeability from one meter to another of same size including registers, measuring chambers and units, discs or pistons as units, change gears, bolts, nuts, and washers without affecting accuracy of new meter.
- J. For water meter vaults provide:
 - 1. 1/4-inch steel or aluminum with stainless steel hinge pins. Door shall open to 90 degrees and automatically lock in that position.
 - 2. Provide approved meter vault covers.

2.02 METER APPLICATIONS

- A. Sizes 5/8-inch to 2-inch Meters: Displacement type (except for constant flow where 2-inch turbine may apply).
- B. Sizes 3-inch and above Meters:
 - 1. Turbines:
 - Processing plants
 - Manufacturing facilities
 - Lawn sprinkler systems
 - Effluent water in treatment plants
 - Booster (pump) stations
 - Level controlled tank filling operations
 - Fire hydrants (transients)
 - Inter-systems sale or transfer
 - Sewer credit/sub-meter
 - 2. Compounds:
 - Multi-family dwellings
 - Motels and hotels
 - Hospitals
 - Schools

Restaurants
Office buildings
Dormitories, nursing homes, department stores, shopping malls, and other commercial establishments

Note: Provide fire service type for sizes larger than 6 inches.

3. Fire Service Type: For designated fire protection lines. Provide proportional or compound type fire service meter assembly (AWWA C 703) when customer elects to use combination of potable and fire protection services in lieu of separate domestic meters and fire services.

2.03 MATERIALS

A. Cold-Water Meters:

1. Displacement Type: AWWA C 700; sizes 5/8 inch up to and including 2 inches; oscillating disc or piston of magnetic drive type; bolted split-case design, with either being removable.
2. Turbine Type: AWWA C 701; Class II; sizes 3 inches through 10 inches; flanged; straight-through measuring chamber; rotor construction: polypropylene or similar non-rubber material with specific gravity of approximately 1.0, equipped with near frictionless replaceable bearings in turbine working against rotor shaft positioned thrust bearing. Transient/Fire Hydrant Meter Inlet: Female fitting for attachment to hose nozzle with National Standard Fire hose thread. Outlet: 2-inch nipple with National Pipe Thread. Include restriction plate to limit flow through meter to 400 gpm at 65 psi.
3. Compound Type: AWWA C 702; sizes 2 inches through 6 inches. Measuring chambers: For use in continuous operation; separate units of copper alloy (minimum 84 percent copper) or approved polymer material, inert in corrosive potable water; with centering device for proper positioning. Measuring pistons: Non-pilot type with division plates of rubber covering vulcanized to stainless steel or other approved material of sufficient thickness to provide minimum piston oscillation noise. Measuring discs: Flat or conical type, one piece, mounted on monel or 316 stainless steel spindle. Measuring chamber strainer screen area: Twice area of main case inlet.
4. Fire-Service Type: sizes 4 inches through 10 inches; turbine-type, compound type, proportional type; AWWA C 703, with separate check valve conforming to AWWA C 510. Determine size of fire meter by adding fire flow and domestic flow.

2.04 STRAINERS

- A. Displacement Potable Water Meters 5/8 inch through 2 inches: Self-straining by means of annular space between measuring chamber and external case or with strainer screens installed

in meter. Provide rigid screens which fit snugly, are easy to remove, with effective straining area at least double that of main case inlet.

- B. Potable Water Meters 2-inch diameter and larger: Equip with separate external strainer with bronze body for diameters less than 8 inches. 8-inch diameter and larger may be cast iron, hot-dipped galvanized or epoxy coating. Strainers: Bolted to inlet side of meter, detachable from meter, easily removable lid. Strainer screen: Made of rounded cast bronze, stainless steel wire, having nominal screen size of 3-1/2 mesh-per-inch (U.S. Series) not less than 45 percent clear area.
- C. Provide separate approved external strainers (when required by meter manufacturer) approved for use in fire service metered connections by Underwriters Laboratories. Bodies: Cast iron or copper alloy. Ends: Flanged in accordance with ASME B 16.1, Class 125. Provide stainless steel basket. Strainers shall be detachable from meter.

2.05 CONNECTIONS AND FITTINGS

- A. Provide pipe for connections in accordance with Section 02501 - Ductile Iron Pipe and Fittings and Section 02506 - Polyvinyl Chloride Pipe. Use restrained joints and flanged joints only.
- B. Fittings:
 - 1. For meters 2 inches and smaller: Same type of fittings as Outlet End fittings for Curb Stop in accordance with Section 02512 - Water Tap and Service Line Installation.
 - 2. For meters 3 inches and larger: Restrained ductile iron; push-on bell joints or mechanical joint fittings between water line and meter vault; Class 125 flanged inside meter vaults; cement mortar lined and sealed.

2.06 LAYING LENGTHS

- A. Minimum laying lengths for meter and standard strainer shall be as shown on Drawings.

PART 3 EXECUTION

3.01 TAPPING AND METER SERVICE INSTALLATION

- A. Refer to Section 02525 - Tapping Sleeves and Valves for tapping requirements.
- B. Meter Service Line:
 - 1. Use pipe and fittings conforming to requirements of Section 02501 - Ductile Iron Pipe and Fittings, or Section 02506 - Polyvinyl Chloride Pipe.

2. Limit pulling and deflecting of joints to limits recommended by manufacturer.
3. Make vertical adjustments with offset bends where room will permit. Minimize number of bends.
4. Provide minimum of ten pipe diameters of straight pipe length upstream and downstream of meter vault.

3.02 METER FITTING HOOKUP

- A. Support meter piping and meter, level and plumb, during installation. Support meters 3 inches and larger with concrete at minimum of two locations.
- B. Use round flanged fittings inside meter box or vault except for mechanical joint to flange adapter. Provide full-face 1/8-inch black neoprene or red rubber gasket material on flanged joints. Provide bolts and nuts made from approved corrosion-resistant material.
- C. Tighten bolts in proper sequence and to correct torque.
- D. Visually check for leaks under normal operating pressure following installation. Repair or replace leaking components.

3.03 METER BOX AND VAULT INSTALLATION

- A. Conform to requirements of Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.
- B. Perform adjustment to existing meter in accordance with Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.

3.04 TESTING

- A. Accuracy registration tests will be conducted in accordance with latest revision of AWWA standard for type and size of meter.
 1. Tests will be run by City of Houston on meters prior to installation at City's meter repair shop. Meters 2 inches and smaller will be tested at random at City's discretion. All 3 inches and larger meters will be tested.
 2. Accuracy of displacement meters during guarantee period shall be as follows:
 - a. Initial period: of 18 months from date of shipment or 12 months from date of installation: 98.5% to 101.5% at standard and minimum flow rates; 98% to 101% at low flow rates.

b. Second period: AWWA new meter accuracy as tested below.

<u>Meter Size</u> <u>(inches)</u>	<u>GUARANTEE PERIOD</u>		<u>TEST FLOW RATE</u>
	Age of Meter <u>Years</u>	Or <u>Million*</u> <u>Gallons</u>	<u>Minimum</u> <u>Rate (gpm)</u>
5/8	>1 to <5	0.5	1/4
1	>1 to <5	1.0	3/4
1-1/2	>1 to <5	2.5	1-1/2
2	>1 to <5	5.5	2

* Total registration.

c. Third period: AWWA new meter accuracy for standard flow rates and AWWA repair meter accuracy for minimum flow rate as tested below.

<u>Meter Size</u> <u>(inches)</u>	<u>GUARANTEE PERIOD</u>		<u>TEST FLOW RATE</u>	
	Age of Meter <u>Years</u>	or <u>Million*</u> <u>Gallons</u>	<u>Standard Flow</u> <u>Rates (gpm)</u>	<u>and</u> <u>Minimum</u> <u>Rate (gpm)</u>
5/8	>5 to <10	1.5	2-15	1/4
1	>5 to <10	2.5	4-40	3/4
1-1/2	>5 to <10	5.0	8-50	1-1/2
2	>5 to <10	10.0	15-100	2

* Total registration.

3. Minimal acceptable accuracy in percent of low flow registration for turbine meters:

<u>Meter Size</u> <u>(inches)</u>	<u>Minimum Flow</u> <u>(gpm)</u>	<u>% Accuracy Required</u>
2	3	95
3	5	95
4	15	95
6	20	95
8	20	95
10	30	95

END OF SECTION

Section 02531

GRAVITY SANITARY SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Gravity sanitary sewers and appurtenances, including stacks and service connections.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for gravity sanitary sewers by open-cut or within Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis, complete in place, including sewer pipe, connections to existing manholes, post installation television inspection and testing. Measurement will be taken along centerline of pipe from centerline to centerline of manholes.
 - 2. Payment for television inspection of existing gravity sanitary sewer will be on a linear foot basis. Measurement will be taken along centerline of pipe from centerline to centerline of manholes. See Section 02558 - Cleaning and Television Inspection.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

- B. Submit proposed methods, equipment, materials and sequence of operations for sewer construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.
- C. Test Reports: Submit test reports and inspection videos as specified in Part 3 of this Section. Video tapes become property of City.

1.04 QUALITY ASSURANCE

- A. Qualifications. Install sanitary sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections. Perform testing in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers.
- B. Regulatory Requirements.
 - 1. Install sewer lines to meet minimum separation distance from potable water line, as scheduled below. Separation distance is defined as distance between outside of water pipe and outside of sewer pipe. When possible, install new sanitary sewers no closer to water lines than 9 feet in all directions. Where this separation distance cannot be achieved, new sanitary sewers shall be installed as specified in this section.
 - 2. Make notification to Project Manager when water lines are uncovered during sanitary sewer installation where minimum separation distance cannot be maintained.
 - 3. Lay gravity sewer lines in straight alignment and grade.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Inspect pipe and fittings upon arrival of materials at job site.

- B. Handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear or free fall. Do not drag pipe and fittings along ground. Do not roll pipe unrestrained from delivery trucks.

- C. Use mechanical means to move or handle pipe. Employ acceptable clamps, rope or slings around outside barrel of pipe and fittings. Do not use hooks, bars, or other devices in contact with interior surface of pipe to lift or move lined pipe.

PART 2 PRODUCTS

2.01 PIPE

- A. Provide piping materials for gravity sanitary sewers of sizes and types indicated on Drawings or as specified.

- B. Unlined reinforced concrete pipe is not acceptable.

2.02 PIPE MATERIAL SCHEDULE

- A. Unless otherwise shown on Drawings, use pipe materials that conform to requirements specified in one or more of following Sections:
 - 1. Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures.

 - 2. Section 02501 - Ductile Iron Pipe and Fittings.

 - 3. Section 02504 - Centrifugally Cast Fiberglass Pipe.

 - 4. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe.

5. Section 02506 - Polyvinyl Chloride Pipe.
 6. Section 02508 - Extra Strength Clay Pipe.
 7. Section 02611 - Reinforced Concrete Pipe.
- B. Where shown on Drawings, provide pipe meeting minimum class, dimension ratio, or other criteria indicated.
- C. Pipe materials other than those listed above shall not be used for gravity sanitary sewers.

2.03 APPURTENANCES

- A. Stacks. Conform to requirements of Section 02534 - Sanitary Sewer Service Stubs or Reconnections.
- B. Service Connections. Conform to requirements of Section 02534 - Sanitary Sewer Service Stubs or Reconnections.
- C. Roof, street or other type of surface water drains shall not be connected or reconnected into sanitary sewer lines.

2.04 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

- A. Bedding and Backfill: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities, Section 02320 - Utility Backfill Materials, and Section 02321 - Cement Stabilized Sand.
- B. Topsoil: Conform to requirements of Section 02911 - Topsoil.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare traffic control plans and set up street detours and barricades in preparation for excavation when construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation.
- B. Provide barricades, flashing warning lights, and warning signs for excavations. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights where work is in progress or where traffic is affected by work.
- C. Perform work in accordance with OSHA standards. Employ trench safety system as specified in Section 02260 - Trench Safety System for excavations over 5 feet deep.
- D. Immediately notify agency or company owning utility line which is damaged, broken or disturbed. Obtain approval from Project Manager and agency or utility company for repairs or relocations, either temporary or permanent.
- E. Remove old pavements and structures including sidewalks and driveways in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.
- F. Install and operate dewatering and surface water control measures in accordance with Section 01578 - Control of Ground Water and Surface Water.
- G. Do not allow sand, debris or runoff to enter sewer system.

3.02 DIVERSION PUMPING

- A. Install and operate required bulkheads, plugs, piping, and diversion pumping equipment to maintain sewage flow and to prevent backup or overflow. Obtain approval for diversion pumping equipment and procedures from Project Manager.
- B. Design piping, joints and accessories to withstand twice maximum system pressure or 50 psi, whichever is greater.
- C. No sewage shall be diverted into area outside of sanitary sewer.
- D. In event of accidental spill or overflow, immediately stop overflow and take action to clean up and disinfect spillage. Promptly notify Project Manager so that required reporting can be made to Texas Natural Resources Conservation Commission and Environmental Protection Agency by Project Manager.

3.03 EXCAVATION

- A. Earthwork. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities. Use bedding as indicated on Drawings.
- B. Line and Grade. Establish required uniform line and grade in trench from benchmarks identified by Project Manager. Maintain this control for minimum of 100 feet behind and ahead of pipe-laying operation. Use laser beam equipment to establish and maintain proper line and grade of work. Use of appropriately sized grade boards which are substantially supported is also acceptable. Protect boards and location stakes from damage or dislocation.
- C. Trench Excavation. Excavate pipe trenches to depths shown on Drawings and as specified in Section 02317 - Excavation and Backfill for Utilities.

3.04 PIPE INSTALLATION BY OPEN CUT

- A. Install pipe in accordance with pipe manufacturer's recommendations and as specified in following paragraphs.
- B. Install pipe only after excavation is completed, bottom of trench fine graded, bedding material is installed, and trench has been approved by Project Manager.
- C. Install pipe to line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in trench so interior surfaces of pipe follow grades and alignment indicated. Provide bell holes where necessary.
- D. Install pipe with spigot ends toward downstream end of flow such that water flows into bell and out the spigot.
- E. Form concentric joint with each section of adjoining pipe so as to prevent offsets.
- F. Keep interior of pipe clean as installation progresses. Remove foreign material and debris from pipe
- G. Provide lubricant, place and drive home newly laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to "home" mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by Project Manager.
- H. Keep excavations free of water during construction and until final inspection.
- I. When work is not in progress, cover exposed ends of pipes with approved plug to prevent foreign material from entering pipe.
- J. Where gravity sanitary sewer is to be installed under existing water line with separation distance of at least 2 feet and less than 9 feet, install new sewer pipe so that one full 18 foot

long pipe is centered on water line crossing. Embed sewer pipe in cement stabilized sand for minimum distance of 9 feet on each side of crossing.

- K. Where gravity sanitary sewer is to be installed under existing water line with separation distance of less than 2 feet, install new sewer using pressure-rated pipe as shown on Drawings. Maintain minimum 6-inch separation distance.
- L. Where the length of the stub is not indicated, install the stub to the right-of-way line and seal the free end with an approved plug.

3.05 PIPE INSTALLATION OTHER THAN OPEN CUT

- A. For installation of pipe by augering, jacking, or tunneling, conform to requirements of specification sections on tunneling augering, jacking and microtunneling work as appropriate.

3.06 INSTALLATION OF APPURTENANCES

- A. Service Connections. Install service connections to conform to requirements of Section 2534 - Sanitary Sewer Service Stubs or Reconnections.
- B. Stacks. Construct stacks to conform to requirements of 02534 - Sanitary Sewer Service Stubs or Reconnections.
- C. Construct manholes to conform to requirements of Section 02081 - Cast-in-Place Concrete Manholes, Section 02082 - Precast Concrete Manholes, and Section 02083 - Fiberglass Manholes, as applicable. Install frames, rings, and covers to conform to requirements of Section 02084 - Frames, Grates, Rings, and Covers.

3.07 INSPECTION AND TESTING

- A. Visual Inspection: Check pipe alignment in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers.
- B. Mandrel Testing. Use Mandrel Test to test flexible pipe for deflection. Refer to Section 02533 - Acceptance Testing for Sanitary Sewers.
- C. Pipe Leakage Test. After backfilling line segment and prior to tie-in of service connections, visually inspect gravity sanitary sewers where feasible, and test for leakage in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers. Maintain piezometer installed to conform with Section 01578 - Control of Ground Water and Surface Water, until acceptance testing is completed.

3.08 BACKFILL AND SITE CLEANUP

- A. Backfill and compact soil in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Backfill trench in specified lifts only after pipe installation is approved by Project Manager.
- C. Repair and replace removed or damaged pavement, curbs, gutters, and sidewalks as specified in Section 02951 - Pavement Repair and Resurfacing.
- D. Provide hydromulch seeding in areas of commercial, industrial or undeveloped land use over surface of ground disturbed during construction and not paved or not designated to be paved. Grade surface at uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil as specified in Section 02911 - Topsoil and apply hydromulch according to requirements of Section 02921 - Hydromulch Seeding.
- E. Provide sodding in areas of residential land use over surface of ground disturbed during construction and not paved or not designated to be paved. Grade surface at uniform slope to

natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil per Section 02911 - Topsoil. Sod disturbed areas in accordance with Section 02922 - Sodding.

3.09 POST-INSTALLATION TELEVISION INSPECTION

- A. Prior to final acceptance of newly constructed gravity sanitary sewers, perform cleaning and closed circuit television inspection. Cleaning shall include utilizing variable pressure water nozzles (3000 psi) and collection, removal, transportation and disposal of sand, debris, and liquid wastes to legal disposal sites.

- B. Select and use closed-circuit television equipment that will produce color video tape. Produce video tape using pan-and-tilt, radial viewing, pipe inspection camera that pans plus and minus 275 degrees and rotates 360 degrees. Use camera with accurate footage counter which displays on monitor exact distance of camera from starting manhole. Use camera with camera height adjustment so that camera lens is always centered at one-half inside diameter, or higher, in pipe being televised. Provide lighting system that allows features and condition of pipe to be clearly seen. Reflector in front of camera may be necessary to enhance lighting in dark or large diameter pipe.

- C. Perform television inspection of gravity sanitary sewers as follows:
 - 1. Videos shall pan beginning and ending manholes to demonstrate that debris has been removed. Camera operator shall slowly pan each service connection and where sewer transitions from one pipe material to another.

 - 2. Video tapes shall be continuous for pipe segments between manholes. Do not leave gaps in video taping of segment between manholes and do not show single segment on more than one video tape.

 - 3. No flow is allowed in gravity sanitary sewer while performing post-installation television inspection.

- D. Provide video tapes in VHS format, recorded at Standard Play (SP). Two labels are required. Place one label on spine and other on face of each video tape. Permanently label each video tape with following information.

Spine of Tape

Wastewater File No.: _____ Contractor's Name: _____ Inspection Type: <input type="checkbox"/> Survey <input type="checkbox"/> Pre-Installation <input type="checkbox"/> Post-Installation Tape No.: _____ Date Televised: _____ Date Submitted: _____ Basin No: _____
--

Face of Tape

Manhole No. From	Manhole No. To	Pipe Diameter	Pipe Length	Street
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

- E. For each video tape provide completed TV Inspection Report, as attached at end of this section. TV Inspection Report is written/narrated log of pipe conditions and service connections, indexed to footage counter.
- F. Upon completion of video tape reviews by Project Manager, Contractor will be notified regarding final acceptance of sewer segment.

END OF SECTION

TELEVISION INSPECTION CODES

HEADER INFORMATION

LOCATION

A	STREET ROW, HEAVY TRAFFIC
B	STREET ROW, LIGHT TRAFFIC
C	EASEMENT, POOR ACCESS
D	EASEMENT, GOOD ACCESS
E	PARKING LOT, POOR ACCESS
F	PARKING LOT, GOOD ACCESS
G	ALLEY, POOR ACCESS
H	ALLEY, GOOD ACCESS
I	OPEN AREA, POOR ACCESS
J	OPEN AREA, GOOD ACCESS

SURFACE COVER

A	ASPHALT STREET
B	CONCRETE STREET
C	SHELL STREET
D	SIDEWALK
E	TREES/SHRUBS
F	CLOSE TO FENCE
G	OPEN AREA
H	MOVABLE BUILDING
I	UNMOVABLE BUILDING
J	OVERHEAD UTILITIES
K	WATERWAY OR RAILWAY
L	HIGHWAY OR RUNWAY
M	PIPE ABOVE GROUND

PIPE TYPE

ABS	ACRYLONITRILE BUTADIENE STYRENE
BRK	BRICK
CIP	CAST IRON PIPE
CMP	CORRUGATED METAL PIPE
CON	POURED IN PLACE CONCRETE
CPP	CURED IN PLACE PIPE
DIP	DUCTILE IRON PIPE
FRP	FIBERGLASS REINFORCED PIPE
PLP	PLASTIC LINED CONCRETE PIPE
PEP	POLYETHYLENE PIPE
PVC	POLYVINYLCHLORIDE PIPE
RCP	REINFORCED CONCRETE PIPE
RPM	REINFORCED PLASTIC MORTAR PIPE
URC	UNREINFORCED CONCRETE PIPE
VCP	VITRIFIED CLAY PIPE

WEATHER

DRY - WET

CODE DESCRIPTIONS

CRACKS

RC-RADIAL CODES	DESCRIPTION	LC-LONGITUDINAL USE IN
A (1)	< 1/2" W, < 1' L	CRK
B (2)	< 1/2" W, 1' - 2' L	CRK
C (3)	< 1/2" W, > 2' L	CRK
D (4)	> 1/2" W, < 1' L	CRK
E (5)	> 1/2" W, 1' - 2' L	CRK
F (6)	> 1/2" W, > 2' L	CRK
G (7)	HOLE IN PIPE - SMALL	
H (8)	PIPE MISSING - < 60°	
I (9)	PIPE MISSING - > 60°	

JOINTS

CODES	DESCRIPTION	USE IN
A (3)	DRP JT > 90% CLEAR	MJ
B (6)	DRP JT 80 - 90% CLEAR	MJ
C (9)	DRP JT < 80% CLEAR	MJ
D (3)	SHF JT > 90% CLEAR	MJ
E (6)	SHF JT 80 - 90% CLEAR	MJ
F (9)	SHF JT < 80% CLEAR	MJ
G (1)	WD JT 2" - 3"	MJ
H (2)	WD JT 3" - 4"	MJ
I (3)	WD JT > 4"	MJ
J (2)	BRK JT - LIGHT	BJ
K (4)	BRK JT - MEDIUM	BJ
L (6)	BRK JT - HEAVY	BJ
N (0)	VISIBLE GASKET	MJ
O (0)	LEAKING AT JOINT	MJ

LATERALS (L)

CODES	DESCRIPTION
A (1)	PRT SER 0" - 1"
B (2)	PRT SER 1" - 2"
C (3)	PRT SER 2" - 3"
D (4)	PRT SER 3" +
E (5)	DEFECTIVE - SERVICE CONN.
F (6)	DEAD/UNUSED SERVICE
G (7)	FACTORY SERVICE
H (0)	PLUMBER SERVICE

ROOTS (R)

CODES	DESCRIPTION
A (1)	ROOTS - LIGHT
B (2)	ROOTS - MEDIUM
C (3)	ROOTS - HEAVY

DEBRIS (D)

CODES	DESCRIPTION
A	DEBRIS - LIGHT
B	DEBRIS - MEDIUM
C	DEBRIS - HEAVY
D	GREASE - LIGHT
E	GREASE - MEDIUM
F	GREASE - HEAVY

INFLOW/INFILTRATION (I)

CODES	DESCRIPTION
A (3)	I/I - LIGHT (0-1 GPM)
B (6)	I/I - MEDIUM (1-5 GPM)
C (9)	I/I - HEAVY (> 5 GPM)
D (2)	I/I - SOME EVIDENCE
E (4)	I/I - CONSIDERABLE EVIDENCE
F (6)	I/I - GREAT EVIDENCE
G (0)	I/I - NO EVIDENCE

ALIGNMENT (A)

CODES	DESCRIPTION
A	BEGIN 1/4 PIPE WATER
B	BEGIN 1/2 PIPE WATER
C	CAMERA UNDERWATER
D	END CAMERA UNDERWATER
E	END 1/2 PIPE WATER
F	END 1/4 PIPE WATER

STRUCTURAL

CODES	DESCRIPTION	USE IN
A (3)	LINE DET - LIGHT	DS
B (6)	LINE DET - MEDIUM	DS
C (9)	LINE DET - HEAVY	DS
D (3)	OVAL < 5%	OS
E (6)	OVAL > 5% & < 10%	OS
F (9)	OVAL > 10%	OS
G (9)	COLLAPSED	CS
H (0)	PIPE DET - HEAVY	DS
L (0)	PIPE DET - LIGHT	DS
M (0)	PIPE DET - MEDIUM	DS
N (0)	PIPE DET - NONE	DS
O	LINE DET - NONE	DS
Z (0)	AT MANHOLE NUMBER	CS

Section 02532

SANITARY SEWER FORCE MAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary sewer force mains.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. Payment for installation of force main pipe by open-cut, augered with or without casing, or within limits of Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis. Measurement will be taken along center line of pipe from end to end. Payment will be made for each foot of force main installed, complete in place including pipe, excavation, bedding, backfill and special backfill, shoring, earthwork, connections to existing manholes, acceptance testing, and pipe and accessories.
2. Payment for installation of force main pipe at a bayou crossing is on a lump sum basis.
3. The Unit Price item identifies line segments between stations as shown on Drawings.
4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCE STANDARDS

- A. ACI 318 - ACI Building Code and Commentary.
- B. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 C and 30 C with a Vitreous Silica Dilatometer.
- C. ASTM D 2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced- Thermosetting-Resin) Pipe.
- D. ASTM D 2992 - Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe and Fittings.

- E. ASTM D 2996 - Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- F. Uni-Bell UNI-B-3 Polyvinyl Chloride (PVC) Pressure Pipe (complying with AWWA C 900).

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed methods, equipment, materials, and sequence of operations for force main construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.
- C. Force mains 24 inches in diameter and larger: Submit shop drawings and design calculations for joint restraint systems using reinforced concrete encasement of pressure pipe and fittings.
- D. Submit qualifications, proposed methods, equipment, materials, and sequence for acceptance testing of pipeline. Submit evidence of experience with pipeline proving by pigging for at least three projects of equal or greater scope; project list shall include dates, size and length of pipe, location, owner name, contact person, and telephone number. Provide certificate of training by manufacturer of pigging equipment being used.
- E. Submit test reports as specified in Part 3 of this Section.

PART 2 PRODUCTS

2.01 PIPE FITTING MATERIAL SCHEDULE

- A. Unless otherwise shown on Drawings, use pipe materials that conform to requirements specified in one or more of the following Sections:
 - 1. Section 02501 - Ductile-Iron Pipe and Fittings.
 - 2. Section 02504 - Cast Fiberglass Pipe.
 - 3. Section 02505 - High Density Polyethylene Solid and Profile Wall Pipe (HDPE).
 - 4. Section 02506 - Polyvinyl Chloride Pipe. Provide Lined Ductile-Iron Fittings in Accordance with Section 02501 - Ductile-Iron Pipe and Fittings.

5. Filament-wound Fiberglass Pipe
- a. Provide dual-angle, filament-wound fiberglass reinforced epoxy pipe with integral epoxy liner and exterior coating in sizes from 4-inch to 16-inch diameter. Conform to requirements of ASTM D 2310 or ASTM D 2996, depending on size and class of pipe required.
 - b. Fiberglass pipe shall have resin rich liner of following thickness:
 - (1) For nominal sizes 4 inches through 6 inches, conform to ASTM D 2310 RTRP 11CX and ASTM D 2996 RTRP 11CX 5430, with minimum liner thickness of 0.020 inch.
 - (2) For nominal sizes 8 inches through 16 inches, conform to ASTM D 2310 RTRP 11FX and ASTM D 2996 RTRP 11FX 3210, with minimum liner thickness of 0.025 inch.
 - (3) The coefficient of linear thermal expansion shall be 8.5×10^{-6} inch/inch/degrees F for 4-inch through 6-inch pipe and 12.0×10^{-6} inch/inch/degrees F for 8-inch through 16-inch pipe in accordance with ASTM D 696.
 - c. Hydrostatic design value shall be not less than 21,000 psi when tested in accordance with ASTM D 2992(B) and not less than 8000 psi when tested according to ASTM D 2992(A).
 - d. Burial depths for pipes with standard wall thickness shall be between 3 feet and 25 feet.
 - e. Joints: Heavy duty threaded coupling system with positive o-ring seals. For 4-inch through 6-inch diameters, provide mechanical joints with fast advance, acme-type threads. Male threaded portion of couplings shall lock mechanical joints for couplings for pipe diameters of 8 inches through 16 inches. Axial movement of couplings shall allow up to 2 degrees of angular deflection without affecting o-ring seal integrity.
 - f. Fittings may be contact molded, compression molded, filament wound, or mitered. Fitting must also be capable of withstanding test pressures.
 - g. Pipes, fittings, and other components in this system shall be rated for service to 150 psig at 120 degrees F. Components shall be rated at or above design pressure of system.

2.02 THRUST RESTRAINT

- A. Unless otherwise shown on Drawings, provide concrete thrust blocking for force mains up to 12-inches in diameter, to prevent movement of buried lines under pressure at bends, tees, caps, valves and hydrants. Blocking shall be Portland cement concrete, as specified in Section 03315 - Concrete for Utility Construction. Place concrete in accordance with details on Drawings. Place thrust blocks between undisturbed ground and fittings. Anchor fittings to thrust blocks so that pipe and fitting joints are accessible for repairs. Concrete shall extend from 6 inches below pipe or fitting to 12 inches above.
- B. For force mains larger than 12 inches in diameter, and where indicated on Drawings, provide restrained joints conforming to requirements of force main pipe material specifications. Install restrained joints for length of pipe on both sides of each bend or fitting for full length shown on Drawings.
- C. Horizontal and vertical bends between zero and 10 degrees deflection angle will not require thrust blocks or harnessed or restrained joints.
- D. Horizontal and vertical bends between 10 degrees and 90 degrees deflection angle shall have thrust restraint as shown on Drawings.
- E. Provide thrust restraint at tees, plugs, blowoff drains, valves, and caps, as indicated.
- F. Reinforced concrete encasement of force main pipe and fittings may be used in lieu of manufactured joint restraint systems. Alternate joint restraint systems using reinforced concrete encasement shall conform to following design requirements.
 - 1. Design calculations shall be performed and sealed by Professional Engineer licensed in State of Texas.
 - 2. Base design calculations upon soil parameters quantified in geotechnical report for site where alternative thrust restraint system is to be installed. When data is not available for site, use parameters recommended by geotechnical engineer.
 - 3. The design system pressure shall be specified test pressure.
 - 4. The following safety factors shall be used in sizing restraint system:
 - a. Apply factor of safety equal to 1.5 for passive soil resistance.
 - b. Apply factor of safety equal to 2.0 for soil friction.
 - 5. Contain encasement entirely within standard trench width and terminate on both ends at pipe bell or coupling.

6. Concrete encasement reinforcement steel shall be designed for all loads, including internal pressure and longitudinal forces. Concrete design shall be in accordance with ACI 318.

PART 3 EXECUTION

3.01 PIPE INSTALLATION BY OPEN-CUT

- A. Perform excavation, bedding, and backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Wrap ductile-iron pipe and fittings with polyethylene wrap in accordance with requirements of Section 02528 - Polyethylene Wrap. Do not install polyethylene wrap on ductile iron pipe protected by cathodic protection system or fusion bonded or polyurethane coated fittings.
- C. Install pipe in accordance with pipe manufacturer's recommendations and as specified in following paragraphs.
- D. Install pipe only after excavation is completed, bottom of trench is fine graded, bedding material is installed, and trench has been approved by Project Manager.
- E. Install pipe to line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in trench so interior surfaces of pipe follow grades and alignment indicated. Provide bell holes where necessary.
- F. Install pipe with spigot ends toward direction of flow. Form concentric joint with each section of adjoining pipe so as to prevent offsets.
- G. Keep interior of pipe clean as installation progresses. Where cleaning after laying pipe is difficult because of small pipe size, use suitable swab or drag in pipe and pull it forward past each joint immediately after joint has been completed. Remove foreign material and debris from pipe.
- H. Provide lubricant, place and drive home newly-laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to "home" mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by Project Manager.
- I. Keep excavations free of water during construction and until final inspection.
- J. When work is not in progress, cover exposed ends of pipes with approved plug to prevent foreign material from entering pipe.

- K. Where sanitary sewer force main is to be installed under existing water line with separation distance of less than 2 feet, install one full joint length of pipe, minimum 18 foot length, centered on water line and maintain minimum 6-inch separation distance.

3.02 PIPE INSTALLATION OTHER THAN OPEN-CUT

- A. For installation of pipe by augering, jacking, or tunneling, conform to requirements of specification section of augering or tunneling work.

3.03 HYDROSTATIC TESTING

- A. After pipe and appurtenance have been installed, test line and drain. Prevent damage to Work or adjacent areas. Use clean water to perform tests.
- B. Project Manager may direct tests of relatively short sections of completed lines to minimize traffic problems or potential public hazards.
- C. Test pipe in presence of Project Manager.
- D. Test pipe at 150 psig or 1.5 times design pressure of pipe, whichever is greater. Design pressure of force main shall be rated total dynamic head of lift station pump.
- E. Test pipe at required pressure for minimum of 2 hours according to requirements of UNI-B-3.
- F. Maximum allowable leakage shall be as calculated by following formula:

$$L = (S) (D) (P^{0.5}) / 133,200$$

Where:

L	=	Leakage in gallons per hour.
S	=	Length of pipe in feet.
D	=	Inside diameter of pipe in inches.
P	=	Pressure in pounds per square inch.

- G. Correct defects, cracks, or leakage by replacement of defective items or by repairs as approved by Project Manager.
- H. Plug openings in force main after testing and flushing. Use cast iron plugs or blind flanges to prevent debris from entering tested pipeline.

3.04 PIGGING TEST

- A. After completion of hydrostatic testing and prior to final acceptance, test force mains longer than 200 feet by pigging to ensure piping is free of obstructions.

- B. Pigs: Provide proving pigs manufactured of open-cell polyurethane foam body, without coating or abrasives which would scratch or otherwise damage interior pipe wall surface or lining. Pigs shall be able to pass through reductions of up to 65 percent of nominal cross-sectional area of pipe. Pigs shall be able to pass through standard fittings such as 45-degree and 90-degree elbows, crosses, tees, wyes, gate valves, or plug valves, as applicable to force main being tested.

- C. Test Execution: Conduct pigging test in presence of Project Manager. Provide at least 48-hours notice of scheduled pigging of force main prior to commencing test.

END OF SECTION

Section 02534

SANITARY SEWER SERVICE STUBS OR RECONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Installation of service stubs in sanitary sewers serving areas where sanitary sewer service did not previously exist.
- B. Reconnection of existing service connections along parallel, replacement, or rehabilitated sanitary sewers.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for sanitary sewer service stubs or service reconnections with stacks located within 5 feet of sanitary sewer main centerline is on unit price basis for each stub or reconnection. Payment will be made for each service stub or reconnection installed complete in place, including service connections, couplings, and adapters disconnecting existing services, reconnecting new service, fittings, excavation, and backfill.
 - 2. Payment for sanitary sewer service stubs or service reconnections without stacks located within 5 feet of sanitary sewer main is on unit price basis for each stub or reconnection. Payment will be made for each service stub or reconnection installed complete in place, including service connections, couplings, and adapters disconnecting existing services, reconnecting new service, fittings, excavation, backfill and testing.
 - 3. Payment for sanitary sewer service lines more than 5 feet laterally from sewer main is on linear foot basis. Measurement will be taken along centerline of pipe from centerline of lateral connection or stack to end of service for service stubs laid in open-cut excavation. Payment will be made for each linear foot of pipe installed, complete in place, including sewer pipe, excavation, shoring, bedding, backfill, and accessories in addition to payment for sewer stubs or service connections with or without stacks. Augered pipe for service stubs will be paid as provided in Section 02448 - Pipe and Casing Augering.
 - 4. Pay estimates for progress payments will be made as measured above according to following schedule:
 - a. An estimate for 95 percent payment will be authorized when reconnection is completely installed and backfilled.

- b. An estimate for 100 percent payment will be authorized when reconnection has been tested as specified in Section 02732 - Acceptance Testing for Sanitary Sewers.
 5. One or more connections discharging into common point are considered one service connection. Contractor shall not add service reconnections without approval of Project Manager. Project Manager may require connections to be relocated to avoid having more than two service connections per reconnection.
 6. Protruding service connections which must be removed to allow liner insertion are paid as service reconnection when connected. If abandoned, they will be paid as abandoned connection.
 7. Payment for abandonment of service connection is on unit price basis for each abandoned connection. No separate payment will be made for abandonment of service connection unless excavation is required. No separate payment will be made for excavation of sanitary sewer services within new or replacement sewer trench.
 8. No separate payment will be made for removal of existing sanitary sewer service stubs. Include payment in unit price for Section 02534 - Sanitary Sewer Service Stubs or Reconnections.
 9. No separate payment will be made for abandoned service connection when service to be abandoned is within 4 feet of active connection. Payment for only one abandoned service connection will be allowed when second abandoned connection is within 4 feet of first.
 10. If faulty remote cut is later corrected using procedures specified for reconnection by excavation, only one reconnection will be allowed for payment.
 11. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- B. ASTM D 3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- C. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

1.04 PERFORMANCE REQUIREMENTS

- A. Accurately locate in field all proposed service stubs along new sanitary sewer main.
- B. Accurately locate in field existing service connections and proposed service stubs along alignment of new parallel or replacement sewer main.

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for each pipe product, fitting, coupling and adapter.
- C. Show reconnected services on record drawings. Give exact distance from each service connection to nearest downstream manhole.

PART 2 PRODUCTS

2.01 PVC SERVICE CONNECTION

- A. As stub outs, use PVC sewer pipe of 4-inch through 10-inch diameter, conforming to ASTM D 1784 and ASTM D 3034, with cell classification of 12454-B. SDR (ratio of diameter to wall thickness) shall be 26 for pipe 10 inches in diameter or less.
- B. PVC pipe shall be gasket jointed with gasket conforming to ASTM D 3212.
- C. Provide service connection pipe in sizes shown on Drawings. For reconnection of existing services, select service connection pipe diameter to match existing service diameter. Reconnections to rehabilitated sanitary sewer mains shall be limited to following maximum service connection diameter:

Sewer Diameter	Maximum Service Connection Diameter
8" or less	4"
10" or greater	6"

- D. Subject to above limits, provide 6-inch service connection when more than one service discharges into single pipe.
- E. Connect service pipes to parallel or replacement sewer mains with prefabricated, full-bodied tee or wye fittings conforming to specifications for sewer main pipe material as specified in other Sections for sewers up to 18 inches in diameter.
- F. Where sewers are installed using pipe augering or tunneling, or where sewer is greater than 18 inches in diameter, use Fowler "Inserta-Tee" to connect service to sewer main.

2.02 PIPE SADDLES

- A. Use pipe saddles only on rehabilitated sanitary sewer mains. Comply with Paragraph 2.01E for new parallel and replacement sanitary sewer mains.
- B. Supply one-piece prefabricated saddle, either polyethylene or PVC, with neoprene gasket to accomplish complete seal. Use saddle fabricated to fit outside diameter of connecting pipe. Protruding lip of saddle must be at least 5/8-inch long with grooves or ridges to retain stainless steel band clamps.
- C. Use 1/2-inch stainless steel band clamps for securing saddles to liner pipe.

2.03 COUPLINGS AND ADAPTERS

- A. For connections between new PVC pipe stubouts and existing service, 4-, 6-, or 8-inch diameter, use flexible adapter coupling consisting of neoprene gasket and stainless steel shear rings with 1/2-inch stainless steel band clamps:
 - 1. Fernco Pipe Connectors, Inc. Series 1055 with shear ring SR-8
 - 2. Band Seal by Mission Rubber Co., Inc.
 - 3. Approved equal.
- B. For connections between new PVC pipe stubout and new service, use rubber-gasket adapter coupling:
 - 1. GPK Products, Inc.
 - 2. IPS & Sewer Adapter
 - 3. Approved equal.

2.04 STACKS

- A. Provide stacks for service connections wherever crown of sewer is 8 feet or more below finished grade.
- B. Construct stacks of same material as sanitary sewer and as shown on Drawings.
- C. Provide stacks of same nominal diameter at sanitary service line.

2.05 PLUGS AND CAPS

- A. Seal upstream end of unconnected sewer service stubs with rubber gasket plugs or caps of same pipe type and size. Provide plugs or caps by GPK Products, Inc., or approved equal.

PART 3 EXECUTION

3.01 PERFORMANCE REQUIREMENTS

- A. Provide minimum of 72 hours notice to customers whose sanitary sewer service will potentially be interrupted.
- B. Accurately field locate service connections, whether in service or not, along rehabilitated sanitary sewer main. For parallel and replacement sewers, service connections may be located as pipe laying progresses from downstream to upstream.
- C. Properly disconnect existing connections from sewer and reconnect to rehabilitated liner, as described in this Section.
- D. Reconnect service connections, including those that go to unoccupied or abandoned buildings or to vacant lots, unless directed otherwise by Project Manager.
- E. Complete reconnection of service lines within 24 hours after cured-in-place liner installation and within 72 hours after disconnection for sliplining, parallel, or replacement sanitary sewer mains.
- F. Reconnect services on cured-in-place liner at 12 feet depth or less by excavation method. Project Manager reserves right to require service connections by excavation when remote cut service connection damages lines.
- G. Reconnection by excavation method shall include stack and fittings and required pipe length to reconnect service line.
- H. Connect services 8 inches in diameter and larger to sewer by construction of manhole. Refer to appropriate Section on manholes for construction and payment.

3.02 PROTECTION

- A. Provide barricades, warning lights, and signs for excavations created for service connections. Conform to requirements of Section 01504 - Temporary Facilities and Controls.
- B. Do not allow sand, debris, or runoff to enter sewer system.

3.03 PREPARATION

- A. Determine existing sewer locations and number of existing service connections from closed-circuit television (CCTV) inspection tapes or from field survey. Accurately field locate existing service connections, whether in service or not. Use existing service locations to connect or reconnect service lines or liner.
- B. For rehabilitated sanitary sewer mains, allow liner to normalize to ambient temperature and recover from imposed stretch. For cured-in-place liners, verify that liner is completely cured.
- C. For new parallel and replacement sanitary sewer mains, complete testing and acceptance of downstream sewers as applicable. Provide for compliance with requirements of Paragraph 3.01E.

3.04 EXCAVATION AND BACKFILL

- A. Excavate in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Perform work in accordance with OSHA standards. Employ Trench Safety System as specified in Section 02260 - Trench Safety System for excavations requiring trench safety.
- C. Install and operate necessary ground water and surface water control measures in accordance with requirements of Section 01578 - Control of Ground Water and Surface Water.
- D. Determine locations where limited access, buildings or structure preclude use of mechanical excavation equipment. Obtain approval from Project Manager for hand excavation.

3.05 RECONNECTION BY EXCAVATION METHOD

- A. Remove portion of existing sanitary sewer main or carrier pipe to expose liner pipe. Provide sufficient working space for installing prefabricated pipe saddle.
- B. Carefully cut liner pipe making hole to accept stubout protruding from underside of saddle.
- C. Strap on saddle using stainless steel band on each side of saddle. Tighten bands to produce watertight seal of saddle gasket to liner pipe.
- D. Remove and replace cracked, offset, or leaking service line for up to 5 feet, measured horizontally, from center of new liner.
- E. Make up connection between liner and service line using PVC sewer pipe and approved fittings and couplings.
- F. Encase entire service connection in cement stabilized sand as shown on Drawings.
- G. Test service connections before backfilling.

3.06 RECONNECTION BY REMOTE METHOD

- A. Make service reconnections using remote-operated cutting tools on cured-in-place liners at depth greater than 12 feet.
- B. Employ method and equipment that restore service connection capacity to not less than 90 percent of original capacity.
- C. Immediately open missed connections and repair holes drilled in error using method approved by Project Manager.

3.07 RECONNECTION ON PARALLEL OR REPLACEMENT SEGMENTS

- A. Install service connections on sewer main.
- B. Remove and replace cracked, offset or leaking service line for up to 5 feet, measured horizontally, from centerline of sanitary sewer main.
- C. Make up connection between main and existing service line using PVC sewer pipe and approved couplings, as shown on Drawings.
- D. Test service connections before backfilling.
- E. Embed service connection and service line as specified for sanitary sewer main as shown on Drawings. Place and compact trench zone backfill in compliance with Section 02317 - Excavation and Backfill for Utilities.

3.08 INSTALLATION OF NEW SERVICE STUBS

- A. Install service connections on sanitary sewer main for each service connection. Provide length of stub indicated on Drawings. Install plug or cap on upstream end of service stub as needed.
- B. Test service connections before backfilling.
- C. Embed service connection and service line as specified for sanitary sewer main, and as shown on Drawings. Place and compact trench zone backfill in compliance with Section 02317 - Excavation and Backfill for Utilities. Install minimum 2-foot length of magnetic locating tape along axis of service stub and 9 inches to 12 inches above crown of pipe, at end of stub.

3.09 TESTING

- A. Test service reconnections and service stubs. Follow applicable procedures given in Section 02533 - Acceptance Testing for Sanitary Sewers to perform smoke testing to confirm reconnection.

- B. Perform post installation CCTV inspection as specified in Section 02558 - Cleaning and Television Inspection to show locations of service connection.

3.10 CLEANUP

- A. Backfill excavation as specified in Section 02317 - Excavation and Backfill for Utilities.
- B. Replace pavement or sidewalks removed or damaged by excavation in accordance with Section 02951 - Pavement Repair and Resurfacing. In unpaved areas, bring surface to grade and slope surrounding excavation. Replace minimum of 4 inches of topsoil and seed according to requirements of Section 02921 - Hydro-mulch Seeding.

END OF SECTION

Section 02611

REINFORCED CONCRETE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforced concrete pipe for sanitary sewers and storm sewers.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

- 1. No separate payment will be made for reinforced concrete pipe under this Section. Include cost in unit price Work as specified in following Sections:

- a. Section 02426 - Sewer Line in Tunnels.
- b. Section 02531 - Gravity Sanitary Sewers.
- c. Section 02631 - Storm Sewers.

- 2. Refer to Section 01270- Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM C 76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- B. ASTM C 443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.
- C. ASTM C 497 - Standard Test Method for Concrete Pipe, Manhole Sections, or Tile.
- D. ASTM C 506 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe
- E. ASTM C 655 - Standard Specification for Reinforced Concrete D-load Culvert, Storm Drain and Sewer Pipe.

- F. ASTM C 877 - Standard Specification for External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit complete product data for pipe, fittings and gaskets for approval. Indicate conformance to appropriate reference standards.
- C. Submit manufacturer's certificate that concrete pipes meet applicable standards.
- D. For jacking pipe, submit drawings and data describing grouting port design and closure procedures when required by Section 02431 - Tunnel Grout, including liner repair, as applicable.

PART 2 PRODUCTS

2.01 REINFORCED CONCRETE PIPE

- A. Conform circular reinforced concrete pipe to requirements of ASTM C 76, for Class III wall "B" thickness. Conform to rubber gasket joints for sanitary sewers and storm sewers and tongue and groove for roadside ditch culverts to ASTM C 443.
- B. Conform reinforced concrete arch pipe to requirements of ASTM C 506 for Class A-III. Joints shall conform to ASTM C 877.
- C. Reinforced concrete elliptical pipe, either vertical or horizontal, shall conform to requirements of ASTM C 507 for Class VE-III for vertical or Class HE-III for horizontal. Use rubber gasket joints conforming to ASTM C 877.
- D. Conform reinforced concrete D-load pipe requirements of ASTM C 655.

2.02 GASKETS

- A. When no contaminant is identified, furnish rubber gasket conforming to ASTM C 443 for circular reinforced concrete pipe and rubber gasket conforming to ASTM C 877 for reinforced concrete elliptical pipe.

- B. Use the following gasket materials for pipes to be installed in potentially contaminated areas, especially where free product is found near elevation of proposed sewer:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer

2.03 LINERS FOR SANITARY SEWER PIPE

- A. Reinforced concrete pipe for sanitary sewers shall be PVC lined and conform to Section 02427 - Plastic Liner for Large Diameter Concrete Sewers and Structures.
- B. Reinforced concrete pipes to be installed in potentially contaminated areas shall have liners recommended by manufacturer as resistant to contaminants identified in Phase II Environmental Site Assessment Report.

2.04 SOURCE QUALITY CONTROL

- A. Representatives of City Engineer will inspect manufacturer's plant and casting operations as deemed necessary.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Conform to requirements of following Sections, as applicable:
1. Section 02448 - Pipe and Casing Augering for Sewers.
 2. Section 02531 - Gravity Sanitary Sewers.
 3. Section 02631 - Storm Sewers.
 4. Section 02441 - Micro-tunneling and Pipe-Jacked Tunnels.
- B. Install reinforced concrete pipe in accordance with manufacturer's recommendations.

END OF SECTION

Section 02631

STORM SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. New storm sewers and appurtenances, modifications to existing storm sewer system and installation of roadside ditch culverts.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for storm sewers, including elliptical or box, installed by open-cut, augered with or without casing, or tunneling is on linear foot basis. Measurement for storm sewers and roadside ditch culverts will be taken along center line of pipe from center line to center line of manholes or from end to end of culverts. Payment will be made for each linear foot installed complete in place, including connections to existing manholes and inlets.
2. Payment for storm sewer leads, including elliptical leads, is on a linear foot basis.
3. Payment for corrugated metal pipe storm sewer outfall, including timber bents, is on a linear foot basis.
4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's literature for product specifications and installation instructions.
- C. Submit proposed methods, equipment, materials, and sequence of operations for sewer construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.

1.04 QUALITY ASSURANCE

- A. The Condition for acceptance shall be watertight storm sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections.
- B. Provide manufacturer's certification to Specifications.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's recommendations.
- B. Handle pipe, fittings, and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks or trailers. Do not use Materials cracked, gouged, chipped, dented, or otherwise damaged shall not be use materials for installation.
- C. Store pipe and fittings on heavy timbers or platforms to avoid contact with ground.
- D. Unload pipe, fittings, and appurtenances as close as practical to location of installation to avoid unnecessary handling.
- E. Keep interiors of pipe and fittings free of dirt and foreign matter.
- F. Store PVC pipe out of direct sunlight.

PART 2 PRODUCTS

2.01 PIPE

- A. Provide piping materials for storm sewers shall be of sizes and types specified unless otherwise indicated on Drawings.
- B. In diameters where material alternatives are available, provide pipe from single manufacturer for each pipe diameter, unless otherwise approved by Project Manager or otherwise shown on Drawings.
- C. Existing pipe that has been removed during construction cannot be reused.

2.02 PIPE MATERIAL SCHEDULE

- A. Storm Sewer Pipe: Use pipe materials that conforming to requirements specified in one or more of the following Sections as shown on the Drawings.

- 1. Section 02506 - Polyvinyl Chloride Pipe. Not allowed in the following applications:
 - a. Potentially Petroleum Contaminated Areas (PPCA).

- b. Augering/ jacking
 - 2. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe. For use only where Storm Sewers are associated with Local Streets, where Local Street is defined by City of Houston Code of Ordinances 42-122.
 - 3. Section 02611 - Reinforced Concrete Pipe.
 - 4. Section 02641 - Monolithic Reinforced Concrete Sewers.
 - 5. Section 02612 - Precast Reinforced Concrete Box Sewers.
 - 6. Section 02642 - Corrugated Metal Pipe use only where Corrugated Metal Pipe is shown on Drawings.
- B. Driveway Culvert Pipe for Streets with Open Ditches: Use pipe materials conforming to requirements specified in one or more of the following Sections as shown on the Drawings.
- 1. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe Use for Residential Culverts only. Use Concrete Pipe for long run culverts.
 - 2. Section 02611 - Reinforced Concrete Pipe.
 - 3. Section 02641 - Monolithic Reinforced Concrete Sewers.
 - 4. Section 02612 - Precast Reinforced Concrete Box Sewers.
- C. Provide pipe meeting minimum class, dimension ratio, or other criteria indicated.
- D. Pipe materials other than those listed above shall not be used for storm sewers.

2.03 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

- A. Bedding and Backfill Material: Conform to requirements of Sections 02317 - Excavation and Backfill for Utilities, Section 02320 - Utility Backfill Material, and Section 2321 – Cement Stabilized Sand, and 02322 – Flowable Fill.
- B. Topsoil: Conform to requirements of Section 02911 - Topsoil.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare traffic control plans and set up street detours and barricades in preparation for excavation when construction will affect traffic. Conform to requirements of Section 01555 Traffic Control and Regulation.
- B. Provide barricades, flashing warning lights, and signs for excavations. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections while Work is in progress or where traffic is affected by Work.
- C. Immediately notify agency or company owning utility lines which are damaged, broken, or disturbed. Obtain approval from Project Manager and agency for repairs or relocations, either temporary or permanent.
- D. Remove old pavements and structures, including sidewalks and driveways in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.
- E. Install and operate dewatering and surface water control measures in accordance with Section 01578 - Control of Ground Water and Surface Water.

3.02 EXCAVATION

- A. Earthwork. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities. Use bedding as indicated on Drawings.
- B. Line and Grade. Establish required uniform line and grade trench from benchmarks identified by Project Manager. Maintain this control for minimum of 100 feet behind and ahead of pipe-laying operation. Use laser beam equipment to establish and maintain proper line and grade of Work. Or use appropriately sized grade boards which are substantially supported.
- C. Trench Excavation. Excavate pipe trenches to level as indicated on Standard Details. Backfill excavation with specified bedding material to level of lower one-third of pipe barrel. Tamp and compact backfill to provide bedding at indicated grade. Form bedding foundation to minimum depth of one-eighth of pipe diameter, but not less than 12 inches.

3.03 PIPE INSTALLATION

- A. Install in accordance with pipe manufacturer's recommendations and as specified in this section.
- B. Install pipe only after excavation is completed, bottom of trench is shaped, bedding material is installed, and trench has been approved by Project Manager.
- C. Install pipe to line and grade indicated on Drawings. Place pipe so that it has continuous bearing of barrel on bedding material with no voids, and is laid in trench so interior surfaces of pipe follows grades and alignments indicated.

- D. Install pipe with bells of pipe facing upstream of anticipated flow.
- E. Form concentric joint with each section of adjoining pipe to prevent offsets.
- F. Place and drive home newly laid sections with a sling or come-a-long winches to eliminate damage to sections. Unless otherwise approved by Project Manager, provide end protection to prevent damage while using back hoes or similar powered equipment to drive home newly laid sections.
- G. Keep interior of pipe clean as installation progresses.
- H. Keep excavations free of water during construction and until final inspection.
- I. When work is not in progress, cover exposed ends of pipes with pipe plug specifically designed to prevent foreign material from entering pipe.
- J. For PVC Pipe:
 - 1. Provide a minimum cover as per City Standard detail from top of pavement to top of pipe, but no less than 2 feet.
 - 2. Accomplish transitions to different material of pipe in a manhole or inlet box. No adapter, coupling for dissimilar pipe, or saddle connections allowed.
 - 3. Provide pipe sections in standard lengths with minimum length of 13 feet. Pipe may be field modified to shorten length no less than 4 feet, unless otherwise approved by Project Manager. Field modify pipe per manufacturer's recommendations.
 - 4. No beveling at joint allowed. Cut to be perpendicular to longitudinal axis.
 - 5. Provide gasketed bell and spigot joints installed per manufacturer's recommendations. Gasketed pipe joints; clean and free of debris, show no leakage after installation.

3.04 PIPE INSTALLATION OTHER THAN OPEN CUT

- A. Conform to requirements of Section 02448 - Pipe and Casing Augering for Sewers where required.
- B. Conform to requirements of Section 02441 - Microtunneling and Pipe-Jacking Tunnels where required.
- C. Not allowed for plastic sewer pipe.

3.05 INSTALLATION OF APPURTENANCES

- A. Construct manholes to conform to requirements of Sections 02081 - Cast-in-place Concrete Manholes, Section 02082 - Precast Concrete Manholes, and Section 2087 - Brick Manholes for Storm Sewers. Install frames, grate rings, and covers to conform to requirements of Section 02084 - Frames, Grates, Rings, and Covers.
- B. Install PVC pipe culverts with approved end treatments. Approved end treatments include concrete headwalls, wingwalls and collars. Refer to City Standards detail for end treatment requirements.
- C. Install HDPE pipe culverts with approved end treatments. Approved end treatments include concrete headwalls, wingwalls and collars. Refer to City Standards detail for end treatment requirements.
- D. Install inlets, headwalls, and wingwalls to conform to requirements of Section 02632 - Cast-in-place Inlets, Headwalls, and Wingwalls and Section 02633 - Precast Concrete Inlets, Headwalls, and Wingwalls.
- E. Rehabilitate existing manholes to conform to requirements of Section 02555 – Manhole Rehabilitation. Adjust manhole covers and inlets to grade conforming to requirements of Section 02086 - Adjusting Manholes, Inlets, and Valve Boxes to Grade.
- F. Dimension for Type C and Type E manholes shall be as shown on Drawings.

3.06 INSPECTION AND TESTING

- A. Perform post installation television inspection in accordance with Section 02531 – Gravity Sanitary Sewers. Hand held cameras may be used in storm sewers in lieu of requirements of Paragraph 3.09 of Section 02531 – Gravity Sanitary Sewers. Clearly stencil distance markings on each joint of pipe to indicate distance from starting manhole when using hand held cameras.

3.07 BACKFILL AND SITE CLEANUP

- A. Backfill trench after pipe installation is inspected and approved by Project Manager.
- B. Backfill and compact soil in accordance with Section 02317 - Excavation and Backfill for Utilities.
- C. Repair and replace removed or damaged pavement and sidewalks as specified in Section 02951 - Pavement Repair and Resurfacing.
- D. In unpaved areas, grade surface as uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil and seed according to requirements of Section 02921 Hydromulch Seeding, or Section 02922 - Sodding, as required.

END OF SECTION

Section 02632

CAST-IN-PLACE INLETS, HEADWALLS AND WINGWALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cast-in-place inlets for storm or sanitary sewers, including cast iron frame and plate or grate.
- B. Cast-in-place headwalls including wingwalls for storm sewers.
- C. Cast-in-place junction box with lid or grate top.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for inlets is on unit price basis for each inlet installed.
 - 2. Payment for headwalls including wingwalls is on unit price basis for each headwall including wingwall installed.
 - 3. Payment for junction box with lid or grate top is on unit price basis for each junction box installed.
 - 4. Payment for inlets and for culvert headwalls including wingwalls and junction boxes includes connection of lines and furnishing and installing frames, grates, rings, and covers.
 - 5. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit shop drawings for approval of design and construction details for cast-in-place units which differ from units shown on Drawings.
- C. Submit manufacturers' data and details for frames, grates, rings, and covers.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: Class A concrete with minimum compressive strength of 4000 psi conforming to requirements of Section 03315 - Concrete for Utility Construction, unless otherwise indicated on Drawings.
- B. Reinforcing Steel: Conform to requirements of Section 03315 - Concrete for Utility Construction.
- C. Concrete Bricks - Conform to requirements of Section 04210 - Brick Masonry for Utility Construction. Use manhole bricks.
- D. Mortar and Hydraulic Cement - Conform to requirements of Section 04061 - Mortar.
- E. Miscellaneous metals: Cast-iron frames, grates, rings, and covers conforming to requirements of Section 02084 - Frames, Grates, Rings, and Covers.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines and grades are correct.
- B. Verify compacted subgrade will support loads imposed by inlets.

3.02 INSTALLATION

- A. Construct units complete in place to dimensions, lines and grades as shown on Drawings.
- B. Excavate in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities.
- C. Construct box section of inlet of Class A concrete or brick.
- D. Plaster brick inlets with 1/2 inch mortar on inside. Use walls for brick inlets minimum of 8 inches thick. Conform to the requirements of Section 04210 - Brick Masonry for Utility Construction.
- E. Forms required for both outside and inside faces of concrete inlet walls, however, when nature of material excavated for inlet can be hand trimmed to smooth vertical face, outside forms may be omitted with approval of Project Manager.

- F. Place reinforcing steel to conform to details shown on Drawings. Provide positive means for holding steel cages in place during concrete placement. Welding of reinforcing steel is not permitted unless noted on Drawings. Maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus 1/2 inch, whichever is less. Regardless of variation, maintain minimum cover of concrete over reinforcement as shown on Drawings.
- G. Chamfer exposed edges unless otherwise indicated on Drawings.

3.03 FINISHES

- A. Cut off inlet leads neatly at inside face of inlet wall. Point up with mortar.
- B. When box section of inlet complete, shape floor of inlet with mortar to conform to detailed Drawings.
- C. Finish concrete surfaces in accordance with requirements of Section 03315 - Concrete for Utility Construction.

3.04 QUALITY CONTROL

- A. Verify that inlets are free of leaks. Repair leaks in approved manner.

3.05 CONNECTIONS

- A. Connect inlet leads to inlets.
- B. Seal leads inside and outside with hydraulic cement.

3.06 BACKFILL

- A. Backfill area of excavation surrounding each completed inlet according to requirements of Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

Section 02751

CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Portland cement concrete paving.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

- 1. Payment for concrete paving is on square yard basis. Separate pay items are used for each different required thickness of pavement.

- 2. Payment for concrete paving, high early strength, is on square yard basis.

- 3. Payment for pavement repair or pavement replacement for utility projects is on a square yard basis and includes base materials in accordance with Section 02951.

- 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- 5. Refer to Paragraph 3.15, Unit Price Adjustment.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

- B. ASTM A185 - Standard Specifications for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

- C. ASTM A497 – Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

- D. ASTM A615 - Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.

- E. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

- F. ASTM C 33 - Standard Specifications for Concrete Aggregates.
- G. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- H. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- I. ASTM C 42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- J. ASTM C 78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third Point Loading).
- K. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- L. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- M. ASTM C 136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- N. ASTM C 138 - Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- O. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- P. ASTM C 150 - Standard Specification for Portland Cement.
- Q. ASTM C 174 - Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.
- R. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- S. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- T. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
- U. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.
- V. TxDOT Tex-203-F - Sand Equivalent Test.
- W. TxDOT Tex-406-A - Material Finer than 75 Φ m (No. 200) Sieve In Mineral Aggregates (Decantation Test for Cement Aggregates).

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed mix design and test data for each type and strength of concrete in Work. Include proportions and actual flexural strength obtained from design mixes at required test ages.
- C. Submit for approval manufacturer's description and characteristics for mixing equipment, and for traveling form paver, when proposed for use.
- D. Submit manufacturer's certificates giving properties of reinforcing steel. Include certificate of compliance with ASTM A 82. Provide specimens for testing when required by Project Manager.

1.05 HANDLING AND STORAGE

- A. Do not mix different classes of aggregate without written permission of Project Manager.
- B. Class of aggregate being used may be changed before or during Work with written permission of Project Manager. Comply new class with specifications.
- C. Reject segregated aggregate. Before using aggregate whose particles are separated by size, mix them uniformly to grading requirements.
- D. Reject aggregates mixed with dirt, weeds, or foreign matter.
- E. Do not dump or store aggregate in roadbed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Portland Cement:
 - 1. Sample and test cement to verify compliance with Standards of ASTM C 150, Type I or Type III.
 - 2. Bulk cement which meets referenced standards may be used when method of handling is approved by Project Manager. When using bulk cement, provide satisfactory weighing devices.
 - 3. Fly ash which meets standards of ASTM C 618 may be used as mineral fill when method of handling is approved by Project Manager.

- B. Water: Conform to requirements for water in ASTM C 94.
- C. Coarse Aggregate: Crushed stone, gravel, or combination thereof, which is clean, hard, and durable, conforms to requirements of ASTM C 33, and has abrasion loss not more than 45 percent by weight when subjected to Los Angeles Abrasion Test (ASTM C 131).

1. Maximum percentage by weight of deleterious substances shall not exceed following values:

<u>Item</u>	<u>Percent by Weight of Total Sample Maximum</u>
Clay lumps and friable particles	3.0
Material finer than 75- μ m (No. 200) sieve:	
Concrete subject to abrasion	3.0*
All Other concrete	5.0*
Coal and lignite:	
Where surface appearance of concrete is of importance	0.5
All other concrete	1.0

- * In case of manufactured sand, when material finer than 75- μ m (No. 200) sieve consists of dust of fracture, essentially free from clay or shale, these limits may be increased to 5 and 7 percent, respectively.

2. Conform coarse aggregate (size 1 1/2 inch to No. 4 sieve) to requirements of ASTM C 33. Use gradation within following limits when graded in accordance with ASTM C 136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>
Retained on 1 3/4" sieve	0
Retained on 1 1/2" sieve	0 to 5
Retained on 3/4" sieve	30 to 65
Retained on 3/8" sieve	70 to 90
Retained on No. 4 sieve	95 to 100
Loss by Decantation Test *Method Tex-406-A	1.0 maximum

- * In case of aggregates made primarily from crushing of stone, when material finer than 200 sieve is dust of fracture essentially free from clay or shale as established by Part III of TxDOT Tex-406-A, percent may be increased to 1.5.

- D. Fine Aggregate: Sand, manufactured sand, or combination thereof, composed of clean, hard, durable, uncoated grains, free from loams or other injurious foreign matter. Conform fine aggregate for concrete to requirements of ASTM C 33. Use gradation within following limits when graded in accordance with ASTM C 136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>

Retained on 3/8" sieve	0
Retained on No. 4 sieve	0 to 5
Retained on No. 8 sieve	0 to 20
Retained on No. 16 sieve	15 to 50
Retained on No. 30 sieve	35 to 75
Retained on No. 50 sieve	65 to 90
Retained on No. 100 sieve	90 to 100
Retained on No. 200 sieve	97 to 100

1. When subjected to color test for organic impurities (ASTM C 40), fine aggregate shall not show color darker than standard color. Fine aggregate shall be subjected to Sand Equivalent Test (Tex-203-F). Sand equivalent value shall not be less than 80, unless higher value is shown on Drawings.
- E. Mineral Filler: Type "C" or Type "F" fly ash of acceptable quality and meeting requirements of ASTM C 618 may be used as mineral admixture in concrete mixture. When fly ash mineral filler is used, store and inspect in accordance with ASTM C 618. Do not use fly ash in amounts to exceed 25 percent by weight of cementitious material in mix design. Cement content may be reduced when strength requirements can be met. Note: When fly ash is used, term "cement" is defined as cement plus fly ash.
- F. Air Entraining Agent: Furnish air entraining agent conforming to requirements of ASTM C 260.
- G. Water Reducer: Water reducing admixture conforming to requirements of ASTM C 494 may be used when required to improve workability of concrete. Amount and type of admixture is subject to approval by Project Manager.
- H. Reinforcing Steel:
1. Provide new billet steel manufactured by open hearth process and conforming to ASTM A 615, Grade 60. Store steel to protect it from mechanical injury and rust. At time of placement, steel shall be free from dirt, scale, rust, paint, oil, or other injurious materials.
 2. Cold bend reinforcing steel to shapes shown. Once steel has been bent, it may not be rebent.
 3. Provide wire fabric conforming to ASTM A 82. Use fabric in which longitudinal and transverse wires have been electrically welded at points of intersection. Welds shall have sufficient strength not to be broken during handling or placing. Conform welding and fabrication of fabric sheets to ASTM A 185.

2.02 EQUIPMENT

- A. Conform Equipment to requirements of ASTM C94.

2.03 MIXING

- A. Flexural strength shall be as specified using test specimens prepared in accordance with ASTM C 31 and tested in accordance with ASTM C78 (using simple beam with third-point loading). Compressive strength shall be as specified using test specimens prepared in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Determine and measure batch quantity of each ingredient, including water for batch designs and all concrete produced for Work. Mix shall conform to these specifications and other requirements indicated on Drawings.
- B. Mix design to produce concrete which will have flexural strength of 500 psi at 7 days and 600 psi at 28 days. Minimum compressive strength shall be 3000 pounds per square inches for 7 days and 3500 pounds per square inches at 28 days when tested in accordance with ASTM C39. Slump of concrete shall be at least 2 inches but no more than 5 inches, when tested in accordance with ASTM C143.
1. Concrete pavement, including curb, curb and gutter, and saw-tooth curb, shall contain at least 5 1/2 sacks (94 pounds per sack) of cement per cubic yard, with not more than 6.5 gallons of water, net, per sack of cement (water-cement ratio maximum 0.57). Determine cement content in accordance with ASTM C 138. Addition of mineral filler may be used to improve workability or plasticity of concrete to limits specified.
 2. Coarse dry aggregate shall not exceed 85 percent of loose volume of concrete.
 3. Add air-entraining admixture to ensure uniform distribution of agent throughout batch. Base air content of freshly mixed air-entrained concrete upon trial mixes with materials to be used in Work, adjusted to produce concrete of required plasticity and workability. Percentage of air entrainment in mix shall be 4 1/2 percent plus or minus 1 1/2 percent. Determine air content by testing in accordance with ASTM C 231.
 4. Use retardant when temperature exceeds 90 degrees F. Proportion as recommended by manufacturer. Use same brand as used for air-entraining agent. Add and batch material using same methods as used for air-entraining agent.
- C. Use high early strength concrete pavement to limits shown on Drawings. Design to meet following:
1. Concrete Mix: Flexural strength greater than or equal to 500 psi at 72 hours.
 2. Cement: Minimum of 7 sacks of cement per cubic yard of concrete.
 3. Water-Cement Ratio maximum of 0.45. Slump of concrete shall a maximum of 5 inches, when tested in accordance with ASTM C 143.

4. Other requirements for proportioning, mixing, execution, testing, etc., shall be in accordance with this Section 02751 - Concrete Paving.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted base is ready to support imposed loads and meets compaction requirements.
- B. Verify lines and grades are correct.

3.02 PREPARATION

- A. Properly prepare, shape and compact each section of subgrade before placing forms, reinforcing steel or concrete. After forms have been set to proper grade and alignment, use subgrade planer to shape subgrade to its final cross section. Check contour of subgrade with template.
- B. Remove subgrade that will not support loaded form. Replace and compact subgrade to required density.

3.03 EQUIPMENT

- A. Alternate equipment and methods, other than those required by this Section, may be used provided equal or better results will be obtained. Maintain equipment for preparing subgrade and for finishing and compacting concrete in good working order.
- B. Subgrade Planer and Template:
 1. Use subgrade planer with adjustable cutting blades to trim subgrade to exact section shown on Drawings. Select planer mounted on visible rollers which ride on forms. Planer frame must have sufficient weight so that it will remain on form, and have strength and rigidity that, under tests made by changing support from wheels to center, planer will not develop deflection of more than 1/8 inch. Tractors used to pull planer shall not produce ruts or indentations in subgrade. When slip form method of paving is used, operate subgrade planer on prepared track grade or have it controlled by electronic sensor system operated from string line to establish horizontal alignment and elevation of subbase.
 2. Provide template for checking contour of subgrade. Template shall be long enough to rest upon side forms and have strength and rigidity that, when supported at center, maximum deflection shall not exceed 1/8 inch. Fit template with accurately adjustable rods projecting downward at 1 foot intervals. Adjust these rods to gauge cross sections of slab bottom when template is resting on side forms.

- C. Machine Finisher: Provide power-driven, transverse finishing machine designed and operated to strike off and consolidate concrete. Machine shall have two screeds accurately adjusted to crown of pavement and with frame equipped to ride on forms. Use finishing machine with rubber tires when it operates on concrete pavement.
- D. Hand Finishing:
 - 1. Provide mechanical strike and tamping template 2 feet longer than width of pavement to be finished. Shape template to pavement section.
 - 2. Provide two bridges to ride on forms and span pavement for finishing expansion and dummy joints. Provide floats and necessary edging and finishing tools.
- E. Burlap Drag or transverse broom for Finishing Slab: Furnish four plies of 10 ounce burlap material fastened to bridge to form continuous strip of burlap full width of pavement. Maintain contact 3 foot width of burlap material with pavement surface. Keep burlap drags clean and free of encrusted mortar.
- F. Vibrators: Furnish mechanically-operated, synchronized vibrators mounted on tamping bar which rides on forms and hand-manipulated mechanical vibrators. Furnish vibrators with frequency of vibration to provide maximum consolidation of concrete without segregation.
- G. Traveling Form Paver: Approved traveling form paver may be used in lieu of construction methods employing forms, consolidating, finishing and floating equipment. Meet requirements of this specification for subgrade, pavement tolerances, pavement depth, alignments, consolidation, finishing and workmanship. When traveling form paver does not provide concrete paving that meets compaction, finish, and tolerance requirements of this Specification, immediately discontinue its use and use conventional methods.
 - 1. Equip traveling paver with longitudinal transangular finishing float adjustable to crown and grade. Use float long enough to extend across pavement to side forms or edge of slab.
 - 2. Ensure that continuous deposit of concrete can be made at paver to minimize starting and stopping. Use conventional means of paving locations inaccessible to traveling paver, or having horizontal or vertical curvature that traveling paver cannot negotiate.
 - 3. Where Drawings require tie bars for adjacent paving, securely tie and support bars to prevent displacement. Tie bars may be installed with approved mechanical bar inserter mounted on traveling-form paver. Replace pavement in which tie bars assume final position other than that shown on Drawings.

3.04 FORMS

- A. Side Forms: Use metal forms of approved shape and section. Preferred depth of form is equal to required edge thickness of pavement. Forms with depths greater or less than

required edge thickness of pavement will be permitted, provided difference between form depth and edge thickness when not greater than 1 inch, and further provided that forms of depth less than pavement edge are brought to required edge thickness by securely attaching wood or metal strips to bottom of form, or by grouting under form. Bottom flange of form shall be same size as thickness of pavement. Aluminum forms are not allowed. Forms shall be approved by Project Manager. Length of form sections shall be not less than 10 feet and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200 foot radius or less. Forms shall have ample strength and shall be provided with adequate devices for secure setting so that when in-place they will withstand, without visible springing or settlement, impact and vibration of finishing machine. In no case shall base width be less than 8 inches for form 8 inches or more in height. Forms shall be free from warp, bends or kinks and shall be sufficiently true to provide straight edge on concrete. Top of each form section, when tested with straight edge, shall conform to requirements specified for surface of completed pavement. Provide sufficient forms for satisfactory placement of concrete. For short radius curves, forms less than 10 feet in length or curved forms may be used. For curb returns at street intersections and driveways, wood forms of good grade and quality may be used.

B. Form Setting:

1. Rest forms directly on subgrade. Do not shim with pebbles or dirt. Accurately set forms to required grade and alignment and, during entire operation of placing, compacting and finishing of concrete, do not deviate from this grade and alignment more than 1/8 inch in 10 feet of length. Do not remove forms for at least 8 hours after completion of finishing operations. Provide supply of forms that will be adequate for orderly and continuous placing of concrete. Set forms and check grade for at least 300 feet ahead of mixer or as approved by Project Manager.
2. Adjacent slabs may be used instead of forms, provided that concrete is well protected from possible damage by finishing equipment. Do not use adjacent slabs for forms until concrete has aged at least 7 days.

3.05 REINFORCING STEEL AND JOINT ASSEMBLIES

- A. Place reinforcing steel and joint assemblies and position securely as indicated on Drawings. Wire reinforcing bars securely together at intersections and splices. Bars and coatings shall be free of rust, dirt or other foreign matter when concrete is placed. Secure reinforcing steel to chairs.
- B. Position pavement joint assemblies at required locations and elevations, and rigidly secure in position. Install dowel bars in joint assemblies, each parallel to pavement surface and to center line of pavement, as shown.
- C. Cut header boards, joint filler, and other material used for forming joints to receive each dowel bar.

- D. Secure in required position to prevent displacement during placing and finishing of concrete.
- E. Drill dowels into existing pavement, secure with epoxy, and provide paving headers as required to provide rigid pavement sections.
- F. Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.

3.06 FIBROUS REINFORCING

- A. Do not use fibrous reinforcing to replace structural, load-bearing, or moment-reinforcing steel.

3.07 PLACEMENT

- A. Place concrete when air temperature taken in shade and away from artificial heat is above 35 degrees F and rising. Do not place concrete when temperature is below 40 degrees F and falling.
- B. Place concrete within 90 minutes after initial water had been added. Remove and dispose of concrete not placed within this period.
- C. Concrete slump during placement shall be 1 to 5 inches, except when using traveling-form paver, slump shall be maximum of 2 inches.
- D. Deposit concrete continuously in successive batches. Distribute concrete in manner that will require as little rehandling as possible. Where hand spreading is necessary, distribute concrete with shovels or by other approved methods. Use only concrete rakes in handling concrete. At placement interruption of more than 30 minutes, place transverse construction joint at stopping point. Remove and replace sections less than 10 feet long.
- E. Take special care in placing and spading concrete against forms and at longitudinal and transverse joints to prevent honeycombing. Voids in edge of finished pavement will be cause for rejection.

3.08 COMPACTION

- A. Consolidate concrete using mechanical vibrators as specified herein. Extend vibratory unit across pavement, not quite touching side forms. Space individual vibrators at close enough intervals to vibrate and consolidate entire width of pavement uniformly. Mount mechanical vibrators to avoid contact with forms, reinforcement, transverse or longitudinal joints.

- B. Furnish enough hand-manipulated mechanical vibrators for proper consolidation of concrete along forms, at joints and in areas not covered by mechanically controlled vibrators.

3.09 FINISHING

- A. Finish concrete pavement with power-driven transverse finishing machines or by hand finishing methods.
 - 1. Hand finish with mechanical strike and tamping template in same width as pavement to be finished. Shape template to pavement section shown on Drawings. Move strike template forward in direction of placement, maintaining slight excess of material in front of cutting edge. Make minimum of two trips over each area. Screed pavement surface to required section. Work screed with combined transverse and longitudinal motion in direction work is progressing. Maintain screed in contact with forms. Use longitudinal float to level surface.
- B. On narrow strips and transitions, finish concrete pavement by hand. Thoroughly work concrete around reinforcement and embedded fixtures. Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge. Tamp concrete with tamping template. Use longitudinal float to level surface.
- C. After completion of straightedge operation, make first pass of burlap drag or transverse broom as soon as construction operations permit and before water sheen has disappeared from surface. Follow with as many passes as required to produce desired texture depth. Permit no unnecessary delays between passes. Keep drag wet, clean and free from encrusted mortar during use.

3.10 JOINTS AND JOINT SEALING

- A. Conform to requirements of Section 02752 - Concrete Pavement Joints.

3.11 CONCRETE CURING

- A. Conform to requirements of Section 02753 - Concrete Pavement Curing.

3.12 TOLERANCES

- A. Test entire surface before initial set and correct irregularities or undulations. Bring surface within requirements of following test and then finish. Place 10 foot straightedge parallel to center of roadway to bridge depressions and touch high spots. Do not permit ordinates measured from face of straight edge to surface of pavement to exceed 1/16 inch per foot from nearest point of contact. Maximum ordinate with 10 foot straightedge shall not exceed 1/8 inch. Grind spots in excess of required tolerances to meet surface test requirements. Restore texture by grooving concrete to meet surface finishing specifications.

3.13 FIELD QUALITY CONTROL

- A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.
- B. Compressive Strength Test Specimens: Make four test specimens for compressive strength test in accordance with ASTM C 31 for each 150 cubic yards or less of pavement that is placed in one day. Test two specimens at 7 days or at number of hours as directed by the Project Manager for high early strength concrete. Test remaining two specimens at 28 days. Test specimens in accordance with ASTM C 39. Minimum compressive strength shall be 3000 pounds per square inch for first two specimens and 3500 pounds per square inch at 28 days.
- C. When compressive test indicates failure, make yield test in accordance with ASTM C 138 for cement content per cubic yard of concrete. When cement content is found to be less than that specified per cubic yard, increase batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. Minimum of one 4 inch core will be taken at random locations per 375 feet per 12 feet lane or 500 square yards of pavement to measure in-place depth. Measure depth in accordance with ASTM C 174. Each core may be tested for 28 day compressive strength according to methods of ASTM C 42. 28 day compressive strength of each core tested shall be a minimum of 3000 pounds per square inch.
- E. Request, at option, three additional cores in vicinity of cores indicating nonconforming in-place depths at no cost to City. In-place depth at these locations shall be average depth of four cores.
- F. Fill cores and density test sections with new concrete paving or non shrink grout.

3.14 NONCONFORMING PAVEMENT

- A. Remove and replace areas of pavement found deficient in thickness by more than 10 percent, or that fail compressive strength tests, with concrete of thickness shown on Drawings.
- B. When measurement of any core is less than specified thickness by more than 10 percent, actual thickness of pavement in this area will be determined by taking additional cores at 10 foot intervals parallel to centerline in each direction from deficient core until, in each direction, core is taken which is not deficient by more than 10 percent. Exploratory cores for

deficient thickness will not be used in averages for adjusted unit price. Exploratory cores are to be used only to determine length of pavement in unit that is to be removed and replaced. Replace nonconforming pavement sections at no additional cost to City.

3.15 UNIT PRICE ADJUSTMENT

- A. Unit price adjustments shall be made for in-place depth determined by cores as follows:
1. Adjusted Unit Price shall be ratio of average thickness as determined by cores to thickness bid upon, times unit price.
 2. Apply adjustment to lower limit of 90 percent and upper limit of 100 percent of unit price.
 3. Average depth below 90 percent but greater than 80 percent may be accepted by Project Manager at adjusted Unit Price of:
 - a. Unit Price Bid - $[2 \times (1 - \text{ratio}) \times \text{Unit Price Bid}]$
 - b. Ratio equals average core thickness divided by thickness bid upon
 - c. 0.9 ratio pays 80 percent of unit price and 0.8 ratio pays 60 percent of unit price.
 4. Average depth below 80 percent will be rejected by Project Manager.

3.16 PAVEMENT MARKINGS

- A. Restore pavement markings to match those existing in accordance with City of Houston standard specifications and details and Project Manager's requirements.

3.17 PROTECTION

- A. Barricade pavement section to prevent use until concrete has attained minimum design strength. Cure barricade pavement section for minimum 72 hours before use. Do not open pavement to traffic until concrete is at least 10 days old. Pavement may be open to traffic earlier provided Contractor pays for testing and additional specimen once 7 day specified strength is obtained. Pavement may be opened when high early strength concrete is used meeting specified 72 hour strength.
- B. High early strength concrete may be used to provide access at driveways, street intersections, esplanades and other locations approved by Project Manager.
- C. On those sections of pavement to be opened to traffic, seal joints, clean pavement, and place earth against pavement edges before permitting use by traffic. Opening of pavement to traffic shall not relieve responsibility for Work.

- D. Maintain concrete paving in good condition until completion of Work.
- E. Repair defects by replacing concrete to full depth.

END OF SECTION

Section 02752

CONCRETE PAVEMENT JOINTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Joints for concrete paving; concrete sidewalks, concrete driveways, curbs, and curb and gutters.
- B. Saw-cutting existing concrete or asphalt pavements for new joints.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for street pavement expansion joints, with or without load transfer, is on linear foot basis.
 - 2. Payment for horizontal dowels is on a unit price basis for each horizontal dowel.
 - 3. No separate payment will be made for formed or sawed street pavement contraction joints and longitudinal weakened plane joints. Include payment in unit price for Concrete Paving.
 - 4. No separate payment will be made for joints for Curb, Curb and Gutter, Saw-tooth Curb, Concrete Sidewalks, and Concrete Driveways. Include payment in unit price for Curb and Gutter, Concrete Sidewalks, and Concrete Driveways.
 - 5. Payment will be made for Preformed Expansion Joints on a linear foot basis only when field conditions require that sidewalk be moved adjacent to existing concrete structure (i.e., street, back of curb, etc.).
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

- B. ASTM D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - C. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - D. ASTM D 3405 - Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements.
 - E. TxDOT Tex-525-C - Tests for Asphalt and Concrete Joint Sealers
- 1.04 SUBMITTALS
- A. Conform to requirements of Section 01330 - Submittal Procedures.
 - B. Submit product data for joint sealing compound and proposed sealing equipment for approval.
 - C. Submit samples of dowel cup, metal supports, and deformed metal strip for approval. Submit manufacturer's recommendation for placing sealant(s).

PART 2 PRODUCTS

2.01 BOARD EXPANSION JOINT MATERIAL

- A. Filler board of selected stock. Use wood of density and type as follows:
 - 1. Clear, all-heart cypress weighing no more than 40 pounds per cubic foot, after being oven dried to constant weight.
 - 2. Clear, all-heart redwood weighing no more than 30 pounds per cubic foot, after being oven dried to constant weight.

2.02 PREFORMED EXPANSION JOINT MATERIAL

- A. Bituminous fiber and bituminous mastic composition material conforming to ASTM D 994 and ASTM D 1751.

2.03 JOINT SEALING COMPOUND

- A. Conform joint sealants to one of sealant classes described in this section.
- B. Conform hot-poured rubber-asphalt compound to ASTM D 3405.
- C. Two-component Synthetic Polymer.

1. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles.
2. Cure sufficiently at average temperature of 25 ∓ 1 C (77 ∓ 2 F) so as not to pick up under wheels of traffic in maximum three hours.
3. Performance requirements, when tested in accordance with TxDOT Tex-525-C, shall meet above curing times and requirements as follows:

Cold-Extruded and Cold-Pourable (Self-Leveling) Specifications	
Property	Requirement
Penetration, 25 C (77 F) 150 g Cone, 5 s, 0.1 mm (in.), maximum	130
Bond and Extension 50%, -29 C (-20 F), 3 cycles: X Dry Concrete Block X Steel blocks (Primed, if recommended by manufacturer) *Steel blocks shall be used when armor joints are specified	Pass Pass
Flow at 70 C (158 F)	None
Water content % by mass, maximum	5.0
Resilience: X Original sample, % min. (cured) X Oven-aged at 70 C (158 F), % min.	50 50
Cold-extruded material only - Cold Flow (10 minutes)	None

After bond and extension test, there shall be no evidence of cracking, separation or other opening that is over 3 millimeters (1/8 inch) deep in sealer or between sealer and test blocks.

4. Provide cold-extruded type for vertical or sloping joints.
 5. Provide self-leveling type for horizontal joints.
- D. Self-Leveling, Low Modulus Silicone or Polyurethane Sealant for Asphaltic Concrete and Portland Cement Concrete Joints. This shall be a single component self-leveling silicone or polyurethane material that is compatible with both asphalt and concrete pavements. The sealer shall not require a primer for bond; a backer rod shall be required which is compatible with the sealant; no reaction shall occur between rod and sealant.

When tested in accordance with TxDOT Tex-525-C, self-leveling sealant shall meet following requirements:

Self-Leveling, Low Modulus Silicone or Polyurethane Sealant	
Property	Requirements
Tack Free Time, 25 ∇ 1 C (77 ∇ 2 F), minutes	120 maximum
Nonvolatile content, % by mass	93 minimum
Tensile Strength and 24 Hour Extension Test: X Initial, 10-day cure, 25 ∇ 1 C (77 ∇ 2 F), kPa (psi) X After Water Immersion, kPa (psi) X After Heat Aging, kPa (psi) X After Cycling, -29 C (-20 F), 50%, 3 cycles, kPa (psi) X 24 Hour Extension	X 21 to 69 (3 to 10) X 21 to 69 (3 to 10) X 21 to 69 (3 to 10) X 21 to 69 (3 to 10) X Pass (All Specimens) After 24 hours, there shall be no evidence of cracking, separation or other opening that is over 3 mm (1/8 in.) deep at any point in the sealer or between the sealer and test blocks.

2.04 LOAD TRANSMISSION DEVICES

- A. Smooth, steel dowel bars conforming to ASTM A 615, Grade 60. When indicated on Drawings, encase one end of dowel bar in approved cap having inside diameter 1/16 inch greater than diameter of dowel bar.
- B. Deformed steel tie bars conforming to ASTM A 615, Grade 60.

2.05 SUPPORTS FOR REINFORCING STEEL AND JOINT ASSEMBLY

- A. Employ supports of approved shape and size that will secure reinforcing steel and joint assembly in correct position during placing and finishing of concrete. Space supports as directed by Project Manager.

PART 3 EXECUTION

3.01 PLACEMENT

- A. When new Work is adjacent to existing concrete, place joints at same location as existing joints in adjacent pavement.

- B. If limit of removal of existing concrete or asphalt pavement does not fall on existing joint, saw cut existing pavement minimum of 2 inches deep to provide straight, smooth joint surface without chipping, spalling or cracks.

3.02 CONSTRUCTION JOINTS

- A. Place transverse construction joint wherever concrete placement must be stopped for more than 30 minutes. Place longitudinal construction joints at interior edges of pavement lanes using No. 6 deformed tie bars, 30 inches long and spaced 18 inches on centers.

3.03 EXPANSION JOINTS

- A. Place 3/4 inch expansion joints at radius points of curb returns for cross street intersections, or as located in adjacent pavement but no further than 80 feet apart. Use no boards shorter than 6 feet. When pavement is 24 feet or narrower, use not more than 2 lengths of board. Secure pieces to form straight joint. Shape board filler accurately to cross section of concrete slab. Use load transmission devices of type and size shown on Drawings unless otherwise specified or shown as "No Load Transfer Device." Seal with joint sealing compound.

3.04 CONTRACTION JOINTS

- A. Place contraction joints at same locations as in adjacent pavement or at spaces indicated on Drawings. Place smoothed, painted and oiled dowels accurately and normal to joint. Seal groove with joint sealing compound.

3.05 LONGITUDINAL WEAKENED PLANE JOINTS

- A. Place longitudinal weakened plane joints at spaces indicated on Drawings. If more than 15 feet in width is poured, longitudinal joint must be saw cut. Seal groove with joint sealing compound.

3.06 SAWED JOINTS

- A. Use sawed joints as alternate to contraction and weakened plane joints. Use circular cutter capable of cutting straight line groove minimum of 1/4 inch wide. Maintain depth of one quarter of pavement thickness. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, continue until completed. Make saw cut with one pass. Complete sawing within 24 hours of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.
- B. Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Maintain ample supply of saw blades at work site during sawing operations. Maintain sawing equipment on job during concrete placement.

3.07 JOINTS FOR CURB, CURB AND GUTTER

- A. Place 3/4 inch preformed expansion joints through curb and gutters at locations of expansion and contraction joints in pavement, at end of radius returns at street intersections and driveways, and at curb inlets. Maximum spacing shall be 120-foot centers.

3.08 JOINTS FOR CONCRETE SIDEWALKS

- A. Provide 3/4 inch expansion joints conforming to ASTM A 1751 along and across sidewalk at back of curbs, at intersections with driveways, steps, and walls; and across walk at intervals not to exceed 36 feet. Provide expansion joint material conforming to ASTM D 994 for small radius curves and around fire hydrants and utility poles. Extend expansion joint material full depth of slab.

3.9 JOINTS FOR CONCRETE DRIVEWAYS

- A. Provide 3/4-inch expansion joints conforming to ASTM D 1751 across driveway in line with street face of sidewalks, at existing concrete driveways, and along intersections with sidewalks and other structures. Extend expansion joint material full depth of slab.

3.10 JOINT SEALING

- A. Seal joints only when surface and joints are dry, ambient temperature is above 50 degrees F and less than 85 degrees F and weather is not foggy or rainy.
- B. Use joint sealing equipment in like new working condition throughout joint sealing operation, and be approved by Project Manager. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.
- C. Clean joints of loose scale, dirt, dust and curing compound. The term joint includes wide joint spaces, expansion joints, dummy groove joints or cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.
- D. Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that, upon completion, surface of sealer within joint will be 1/4 inch above level of adjacent surface or at elevation as directed.

3.11 PROTECTION

- A. Maintain joints in good condition until completion of Work.
- B. Replace damaged joints material with new material as required by this Section.

END OF SECTION

Section 02753

CONCRETE PAVEMENT CURING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Curing of Portland cement concrete paving.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for concrete curing under this Section. Include payment in unit price for Concrete Paving, Concrete Sidewalks, Concrete Driveways, Curbs, and Curb and Gutters.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM C 156 - Standard Test Method for Water Retention by Concrete Curing Materials.
- B. ASTM C 171 - Standard Specifications for Sheet Materials for Curing Concrete.
- C. ASTM C 309 - Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's product data for cover materials and liquid membrane-forming compounds.

PART 2 PRODUCTS

2.01 COVER MATERIALS FOR CURING

- A. Conform curing materials to one of the following:
 - 1. Polyethylene Film: Opaque pigmented white film conforming to requirements of ASTM C 171.
 - 2. Waterproofed Paper: Paper conforming to requirements of ASTM C 171.
 - 3. Cotton Mats: Single layer of cotton filler completely enclosed in cover of cotton cloth. Mats shall contain not less than 3/4 of a pound of uniformly distributed cotton filler per square yard of mat. Cotton cloth used for covering materials shall weigh not less than 6 ounces per square yard. Stitch mats so that mat will contact surface of pavement at all points when saturated with water.

2.02 LIQUID MEMBRANE-FORMING COMPOUNDS

- A. Conform liquid membrane-forming compounds to ASTM C 309. Membrane shall restrict loss of water to not more than 0.55 kg/m^2 in 72 hours using test method ASTM C 156.

PART 3 EXECUTION

3.01 CURING REQUIREMENT

- A. Cure concrete pavement by protecting against loss of moisture for period of not less than 72 hours immediately upon completion of finishing operations. Do not use membrane curing for concrete pavement to be overlaid by asphalt concrete.
- B. Failure to provide sufficient cover material shall be cause for immediate suspension of concreting operations.

3.02 POLYETHYLENE FILM CURING

- A. Immediately after finishing surface, and after concrete has taken its initial set, apply water in form of fine spray. Cover surface with polyethylene film so film will remain in direct contact with surface during specified curing period.
- B. Cover entire surface and both edges of pavement slab. Overlap joints in film sheets minimum of 12 inches. Immediately repair tears or holes occurring during curing period by placing acceptable moisture-proof patches or replacing.

3.03 WATERPROOFED PAPER CURING

- A. Immediately after finishing surface, and after concrete has taken its initial set, apply water in form of fine spray. Cover surface with waterproofed paper so paper will remain in direct contact with surface during specified curing period.
- B. Prepare waterproofed paper to form blankets of sufficient width to cover entire surface and both edges of pavement slab, and not be more than 60 feet in length. Overlap joints in blankets caused by joining paper sheets not less than 5 inches and securely seal with asphalt cement having melting point of approximately 180 degrees F. Place blankets to secure overlap of at least 12 inches. Immediately repair tears or holes appearing in paper during curing period by cementing patches over defects.

3.04 COTTON MAT CURING

- A. Immediately after finishing surface, and after concrete has taken its initial set, completely cover surface with cotton mats, thoroughly saturated before application, maintaining contact with surface of pavement equally at all points.
- B. Keep mats on pavement for specified curing period. Keep mats saturated so that, when lightly compressed, water will drip freely from them. Keep banked earth or cotton mat covering edges saturated.

3.05 LIQUID MEMBRANE-FORMING COMPOUNDS

- A. Immediately after free surface moisture, and after concrete has dispersed, apply liquid membrane-forming compound in accordance with manufacturer's instructions.
- B. Moisten concrete by water fogging prior to application of membrane when surface has become dry.
- C. Seal concrete surface with single coat at rate of coverage recommended by manufacturer and directed by Project Manager, but not less than one gallon per 200 square feet of surface area.

3.06 TESTING MEMBRANE

- A. Treated areas will be visually inspected for areas of lighter color of dry concrete as compared to dump concrete. Test suspected areas by placing few drops of water on surface. Membrane passes test when water stands in rounded beads or small pools which can be blown along surface of concrete without wetting surface.
- B. Reapply membrane compound immediately at no cost to City when membrane fails above test.

END OF SECTION

Section 02754

CONCRETE DRIVEWAYS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Portland cement concrete driveways.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for concrete driveways is on square foot basis, including excavation.
 - 2. No payment will be made for work in areas where driveway has been removed or replaced for Contractor's convenience.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for reinforcing steel of Section 02751 - Concrete Paving.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02752 - Concrete Pavement Joints.
- E. Subgrade Materials: Conform to subgrade material requirements of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, or Section 02338 - Portland Cement Stabilized Subgrade.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare subgrade in accordance with applicable portions of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, and Section 02338 - Portland Cement Stabilized Subgrade.

3.02 PLACEMENT

- A. Place and finish concrete in accordance with applicable portions of Section 02751 - Concrete Paving.

3.03 JOINTS

- A. Install joints in concrete driveway in accordance with Section 02752 - Concrete Pavement Joints.

3.04 CONCRETE CURING

- A. Cure concrete driveway in accordance with Section 02753 - Concrete Pavement Curing.

3.05 PROTECTION

- A. Conform to applicable requirements of Section 02753 - Concrete Pavement Curing.

END OF SECTION

Section 02771

CURB, CURB AND GUTTER, AND HEADERS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Reinforced concrete curb, reinforced monolithic concrete curb and gutter, and mountable curb.
- B. Paving headers and railroad headers poured monolithically with concrete base or pavement.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for curbs, curbs and gutter, and esplanade curbs is on linear foot basis measured along face of curb.
 - 2. Payment for 3 foot concrete valley gutter is on a linear foot basis.
 - 3. Payment for mountable concrete curbs is on a square foot basis.
 - 4. Payment for concrete paving headers and concrete railroad headers is on a linear foot basis.
 - 5. Payment for headers is on linear foot basis measured between lips of gutters adjacent to concrete base and measured between backs of curbs adjacent to concrete pavement.
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit details of proposed form work for approval.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements for welded wire fabric of Section 02751 - Concrete Paving.
- C. Grout: Nonmetallic, nonshrink grout containing no chloride producing agents conforming to following requirements.
 - 1. Compressive strength
 - a. at 7 days: 3500 psi
 - b. at 28 days: 8000 psi
 - 2. Initial set time: 45 minutes
 - 3. Final set time: 1.5 hours
- D. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Pavement Joints.
- E. Expansion Joint Filler: Conform to material requirements for expansion joint filler of Section 02752 - Concrete Pavement Joints.
- F. Mortar: Mortar finish composed of one part Portland cement and 1 1/2 parts of fine aggregate. Use only when approved by Project Manager.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare subgrade in accordance with applicable portions of sections on excavation and fill, embankment, and subgrade and roadbed.

3.02 PLACEMENT

- A. Guideline: Set to follow top line of curb. Attach indicator to provide constant comparison between top of curb and guideline. Ensure flow lines for monolithic curb and gutters conform to slopes indicated on Drawings.

- B. Forms: Brace to maintain position during pour. Use metal templates cut to section shown on Drawings.
- C. Reinforcement: Secure in position so that steel will remain in place throughout placement. Reinforcing steel shall remain at approximate center of base or pavement as indicated on Drawings.
- D. Joints: Place in accordance with Section 02752 - Concrete Pavement Joints. Place dummy groove joints at to match concrete pavement joints at right angles to curb lines. Cut dummy grooves 1/4 inch deep using approved edging tool.
- E. Place concrete in forms to required depth. Consolidate thoroughly. Do not permit rock pockets in form. Entirely cover top surfaces with mortar.

3.03 MANUAL FINISHING

- A. After concrete is in place, remove front curb forms. Form exposed portions of curb, and of curb and gutter, using mule which conforms to curb shape, as shown on Drawings.
- B. Thin coat of mortar may be worked into exposed face of curb using mule and two-handled wooden darby at least 3 feet long.
- C. Before applying final finish move 10 foot straightedge across gutter and up curb to back form of curb. Repeat until curb and gutter are true to grade and section. Lap straightedge every 5 feet.
- D. Steel trowel finish surfaces to smooth, even finish. Make face of finished curb true and straight.
- E. Edge outer edge of gutter with 1/4 inch edger. Finish edges with tool having 1/4 inch radius.
- F. Finish visible surfaces and edges of finished curb and gutter free from blemishes, form marks and tool marks. Finished curb or curb and gutter shall have uniform color, shape and appearance.

3.04 MECHANICAL FINISHING

- A. Mechanical curb forming and finishing machines may be used instead of, or in conjunction with, previously described methods, when approved by Project Manager. Use of mechanical methods shall provide specified curb design and finish.

3.05 CURING

- A. Immediately after finishing operations, cure exposed surfaces of curbs and gutters in accordance with Section 02753 - Concrete Pavement Curing.

3.06 TOLERANCES

- A. Top surfaces of curb and gutter shall have uniform width and shall be free from humps, sags or other irregularities. Surfaces of curb top, curb face and gutter shall not vary more than 1/8 inch from edge of straightedge laid along them, except at grade changes.

3.07 PROTECTION

- A. Maintain curbs and gutters in good condition until completion of Work.
- B. Replace damaged curbs and gutters to comply with this Section.

END OF SECTION

Section 02775

CONCRETE SIDEWALKS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforced concrete sidewalks.
- B. Wheelchair ramps.
- C. Reinforced slope paving.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for concrete sidewalks is on square foot basis.
 - 2. No payment will be made for work outside these limits or in areas where driveway has been removed or replaced for Contractor's convenience.
 - 3. Payment for wheelchair ramps of each type specified is on square foot basis. Removal and replacement of existing sidewalk, curb or curb and gutter and saw-cutting is paid by unit cost for each item. Sodding will be paid one foot on each side of sidewalk unless otherwise noted. Staining of wheelchair ramps is included in cost of ramp.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in Field.
- B. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- C. ASTM C 42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

- D. ASTM C 138 - Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- E. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- F. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
- G. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- H. Texas Accessibility Standards of Architectural Barriers Act, Article 9102, Texas Civil Statutes.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certified testing results and certificates of compliance.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: Conform to material and proportion requirements for concrete of Section 02751 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements of Section 02751 - Concrete Paving for reinforcing steel. Use No. 3 reinforcing bars.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 02752 - Concrete Pavement Joints.
- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 02752 - Concrete Pavement Joints.
- E. Forms: Use straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness. The use of 2 inch by 4 inch lumber as forms will not be allowed.
- F. Sand Bed: Conform to material requirements for bank run sand of Section 02320 - Utility Backfill Materials.
- G. Sodding: Conform to material requirements for sodding of Section 02922 - Sodding.

- H. Coloring for wheelchair ramps: Conform to material requirements for colored concrete of Section 02761 - Colored Concrete for Medians and Sidewalks. Color shall be Brick Red or as shown on the drawings.

PART 3 EXECUTION

3.01 REPLACEMENT

- A. Replace sidewalks and slope paving which are removed or damaged during construction with thickness and width equivalent to one removed or damaged, unless otherwise shown on Drawings. Finish surface (exposed aggregate, brick pavers, etc.) to match existing sidewalk.
- B. Provide replaced and new sidewalks with wheelchair ramps when sidewalk intersects curb at street or driveway.

3.02 PREPARATION

- A. Identify and protect utilities which are to remain.
- B. Protect living trees, other plant growth, and features designated to remain.
- C. Conduct clearing and grubbing operations in accordance with Section 02233 - Clearing and Grubbing.
- D. Excavate subgrade 6 inches beyond outside lines of sidewalk. Shape to line, grade and cross section. For soils with plasticity index above 40 percent, stabilize soil with lime in accordance with Section 02336 – Lime-Stabilized Subgrade. Compact subgrade to minimum of 90 percent maximum dry density at optimum to 3 percent above optimum moisture content, as determined by ASTM D 698.
- E. Immediately after subgrade is prepared, cover with compacted sand bed to depth as shown on Drawings. Lay concrete when sand is moist but not saturated.

3.03 PLACEMENT

- A. Setting Forms: Straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness. Use of 2 by 4's as forms will not be allowed. Securely stake forms to line and grade. Maintain position during concrete placement.
- B. Reinforcement:
 - 1. Install reinforcing bars.
 - 2. Install reinforcing steel as shown on the drawings. Lay longitudinal bars in walk

continuously, except through expansion joints.

3. Use sufficient number of chairs to support reinforcement in manner to maintain reinforcement in center of slab vertically during placement.
4. Drill dowels into existing paving, sidewalk and driveways, secure with epoxy, and provide headers as required.
5. Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.

- C. Expansion Joints: Install expansion joints with load transfer units in accordance with Section 02752 - Concrete Pavement Joints.
- E. Place concrete in forms to specified depth and tamp thoroughly with "jitterbug" tamp, or other acceptable method. Bring mortar to surface.
- F. Strike off to smooth finish with wood strike board. Finish smoothly with wood hand float. Brush across sidewalk lightly with fine-haired brush.
- G. Apply coating to wheelchair ramp with contrasting color in accordance with Section 02761 - Colored Concrete for Medians and Sidewalks.
- H. Unless otherwise indicated on Drawings, mark off sidewalk joints 1/8 inch deep, at spacing equal to width of walk. Use joint tool equal in width to edging tool.
- I. Finish edges with tool having 1/4 inch radius.
- J. After concrete has set sufficiently, refill space along sides of sidewalk to one-inch from top of walk with suitable material. Tamp until firm and solid, place sod as applicable. Dispose of excess material in accordance with Section 01576 - Waste Material Disposal. Repair driveways and parking lots damaged by sidewalk excavation in accordance with Section 02951 - Pavement Repair and Resurfacing.

3.04 CURING

- A. Conform to requirements of Section 02753 - Concrete Pavement Curing.

3.05 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

- B. Compressive Strength Test Specimens: Four test specimens for compressive strength test will be made in accordance with ASTM C 31 for each 30 cubic yards or less of sidewalk that is placed in one day. Two specimens will be tested at 7 days. Remaining two specimens will be tested at 28 days. Specimens will be tested in accordance with ASTM C 39. Minimum compressive strength: 2500 psi at 7 days and 3000 psi at 28 days.
- C. Yield test for cement content per cubic yard of concrete will be made in accordance with ASTM C 138. When cement content is found to be less than that specified per cubic yard, reduce batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. If the Contractor places concrete without notifying the laboratory, the City will have the concrete tested by means of core test as specified in ASTM C 42. When concrete does not meet specification, cost of test will be deducted from payment.
- E. Sampling of fresh concrete shall be in accordance with ASTM C 172.
- F. Take slump tests when cylinders are made and when concrete slump appears excessive.
- G. Concrete shall be acceptable when average of two 28 day compression tests is equal to or greater than minimum 28 day strength specified.
- H. If either of two tests on field samples is less than average of two tests by more than 10 percent, that entire test shall be considered erratic and not indicative of concrete strength. Core samples will be required of in-place concrete in question.
- I. If 28 day laboratory test indicates that concrete of low strength has been placed, test concrete in question by taking cores as directed by Project Manager. Take and test at least three representative cores as specified in ASTM C 42 and deduct cost from payment due.

3.06 NONCONFORMING CONCRETE

- A. Remove and replace areas that fail compressive strength tests, with concrete of thickness shown on Drawings.
- B. Replace nonconforming sections at no additional cost to City.

3.07 PROTECTION

- A. Maintain newly place concrete in good condition until completion of Work.
- B. Replace damaged areas.

END OF SECTION

SECTION 02791**PLAYGROUND SURFACING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Protective surfacing for roof plaza level playground area.

1.02 REFERENCE STANDARDS

- A. ASTM D 2047 - Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine; 2004.
- B. ASTM F 1292 - Standard Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment; 2004.
- C. ASTM F 1487 - Standard Consumer Safety Performance Specification for Playground Equipment for Public Use; 2007a.

1.03 DEFINITIONS

- A. Use Zone: The area beneath and immediately adjacent to a play structure or equipment (play event) that is designated for unrestricted circulation around equipment, and on whose surface it is predicted that a user would land when falling from or exiting the equipment.
- B. Critical Fall Height: The maximum fall height at which the protective surfacing meets the requirements of ASTM F 1292.
- C. Fall Height: The vertical distance between the finished elevation of the designated play surface and the finished elevation of the protective surfacing beneath it as defined by ASTM F 1487.
- D. Protective Surfacing: Resilient ground surfacing. The characteristics of the protective surfacing are based on the fall height of the playground equipment. Changes in either the surfacing or the fall height, particularly reducing the resilience of the protective surfacing or increasing the fall height, will reduce safety-related performance.
- E. Subbase: A layer under the resilient layer of the protective surfacing but over the subgrade; may be rigid, as in concrete or bituminous, or aggregate.
- F. Subgrade: The surface of the ground on which the protective surfacing is installed.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: For all manufactured surfacing products, provide manufacturer's product data showing materials of construction, compliance with specified standards, installation procedures, and safety limitations.

1.05 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum 5 year warranty for playground surfacing.

PART 2 PRODUCTS**2.01 DESIGN CRITERIA**

- A. Because the safety of the playground depends on strict conformance to the design criteria, this information is provided for Contractor's information.
 - 1. The top elevation of the protective surfacing is intended to be flush with adjacent grades.

2. Use Zone: The protective surfacing has been designed to provide acceptable impact attenuation as defined in ASTM F 1292 for Critical Height of 6 feet.

2.02 MATERIALS

- A. Tile Surfacing: Factory-molded rubber tile with impact attenuating design and solid, uniform top surface; adhered to a rigid subbase.
 1. Coefficient of Friction: 0.8, minimum, when tested in accordance with ASTM D 2047.
 2. Color: As selected from manufacturer's full range.
 3. Product: Ultra Tile manufactured by Surface America www.surfaceamerica.com.

END OF SECTION

Section 02811

LANDSCAPE IRRIGATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe and fittings, valves, sprinkler heads, and accessories.
- B. Control system.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for landscape irrigation will be made under this Section on lump sum basis.
 - 2. Payment for capped irrigation sleeve, for connection to future system expansion, is on linear foot basis.
 - 3. Refer to Section 01270 - Measurement and Payment.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ANSI/ASTM D 2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
- B. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure - Rated Pipe (SDR Series).

1.04 SYSTEM DESCRIPTION

- A. Electric solenoid controlled underground irrigation system.
- B. Source Power: 120 volt

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in performing work of this section with minimum three years documented experience.

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable code for piping and component requirements.

1.08 PRE-INSTALLATION CONFERENCE

- A. Convene one week prior to commencing work of this Section.

1.09 COORDINATION

- A. Coordinate work with site landscape grading and delivery of plant life.

1.10 EXTRA MATERIALS

- A. Furnish extra components under provisions of Section 00410 - Bid Form.
 - 1. Two sprinkler heads of each type and size.
 - 2. Two valve box keys.
 - 3. Two wrenches for each type head core and for removing and installing each type head.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

- A. Pipe shall be continuously and permanently imprinted with manufacturer's name, size, schedules, type, and working pressure.
- B. PVC Pipe ASTM D 2241; 200 psi pressure rated upstream from controls, 160 psi downstream; solvent welded sockets rubber gasket joints.
- C. Fittings: Type and style of connection to match pipe.
- D. Solvent Cement: ANSI/ASTM D 2564 for PVC pipe and fittings.
- E. Sleeve material: 4 inch schedule 40 PVC.

2.02 OUTLETS

- A. Manufacturer's or approved equal:
 - 1. Rainbird Model 1804.
 - 2. Rainbird Model 1812
 - 3. Hunter Model PGP
- B. Rotary type sprinkler head: Pop-up type with screens; fully adjustable for flow and pressure; size as indicated; with letter or symbol designating degree of arc and arrow indicating center of spray pattern.
- C. Spray Type Sprinkler Head: Pop-up head with full circle, half circle, third circle, quarter circle, and square pattern.

2.03 VALVES

- A. Manufacturer's or approved equal:
 - 1. Rainbird Model PEB Series
- B. Gate Valves: Bronze construction, non-rising stem, and sized to line.
- C. Backflow Preventers: FEBCO 765 Bronze body construction, reduced pressure zone or pressure vacuum breaker type.
- D. Valve Box and Cover: rectangular 10 inches by 4 inches or 9 inches round.

2.04 CONTROLLER

- A. Manufacturer's or approved equal:
 - 1. Rainbird Model RC1260C
- B. Valves: Electric solenoid wiring including required fittings and accessories.
- C. Wire conductors: color coded.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify site conditions under provisions of Section 01312 - Coordination and Meetings.
- B. Verify location of existing utilities.
- C. Verify that required utilities are available, in proper location, and ready for use.

3.02 PREPARATION

- A. Piping layout indicated is diagrammatic only. Route piping to avoid plants, ground cover, and structures.
- B. Layout and stake locations of system components.
- C. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system.

3.03 TRENCHING

- A. Trench and filling as required.
- B. Trench size:
 - 1. Minimum cover over installed supply piping: 18 inches.
 - 2. Minimum cover over installed branch piping: 12 inches.
 - 3. Minimum cover over installed outlet piping: 12 inches.
- C. Trench to accommodate grade changes.
- D. Maintain trenches free of debris, material, or obstructions that may damage pipe.
- E. Do not leave trenches open overnight.

3.04 INSTALLATION

- A. Install pipe, valves, controls, and outlets in accordance with manufacturer's instructions.
- B. Connect to utilities.
- C. Set outlets and box covers at finish grade elevations.

- D. Install control wiring as required. Provide 10-inch expansion coil at each valve to which controls are connected, and at 100 foot intervals. Bury wire beside pipe. Mark valves with neoprene valve markers containing locking device. Set valve markers in 160 psi PVC pipe risers exiting from top of valve to finish grade.
- E. After piping is installed, but before outlets are installed and filling commences, open valves and flush system with full head of water.
- F. Coordinate pipe installation with conduit installation.

3.05 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed.
- B. Prior to filling, test system for leakage for whole system to maintain 100 psi pressure for one hour.

3.06 FILLING

- A. Cover with 3 inches of sand over piping; fill trench and compact to subgrade elevation. Protect piping from displacement.

3.07 ADJUSTING

- A. Adjust control system to achieve time cycles required.
- B. Change and adjust head types for full water coverage as directed.

3.08 DEMONSTRATION

- A. Demonstrate system under provisions of Section 01755 - Starting Systems.
- B. Instruct City's personnel in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance material as basis for demonstration.

END OF SECTION

SECTION 02821**CHAIN LINK FENCES AND GATES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Fence framework, fabric, and accessories.
- B. Manual gates and related hardware.

1.02 REFERENCE STANDARDS

- A. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.
- B. ASTM F 567 - Standard Practice for Installation of Chain-Link Fence; 2007.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.
- C. Manufacturer's Installation Instructions: Indicate installation requirements, post foundation anchor bolt templates, and _____.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Chain Link Fences and Gates:
 - 1. Payne Fence; Product Guardian Fence System. www.paynefence.com
 - a. Duty Guard
 - b. Sentry Guard
 - 2. Substitutions: See Section 01600 - Product Requirements.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install framework, fabric, accessories and gates in accordance with ASTM F 567.
- B. Do not attach the hinged side of gate to building wall; provide gate posts.

END OF SECTION

SECTION 02841

STEEL GUARDRAIL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Steel guardrail and steel posts.

PART 2 PRODUCTS

END OF SECTION

SECTION 02871**BICYCLE RACKS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Bicycle racks.

1.02 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Indicate size, shape, and dimensions, including clearances from adjacent walls, doors, and obstructions.
- D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Handle racks with sufficient care to prevent scratches and other damage to the finish.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Bicycle Racks: Tubular steel pipe formed to allow at least one bicycle to lock simultaneously on each bend and each end, securing one wheel and part of the frame.
 - 1. Capacity: 11 bicycles.
 - 2. Mounting: In-ground anchor.
 - 3. Finish: Hot-dipped galvanized, maintenance-free and weather-resistant.
 - 4. Accessories: In-ground grout cover.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine surfaces to receive bicycle racks.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Do not begin installation until unsatisfactory substrates have been properly repaired.

3.02 PREPARATION

- A. Ensure surfaces to receive bicycle racks are clean, flat, and level.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install bicycle racks level, plumb, square, and correctly located as indicated on the drawings.
- C. In-Ground Anchor Installation:
 - 1. Prepare holes in size according to manufacturer's instructions.
 - 2. Place anchoring bolts through the holes in the pipe.

3. Lower rack into holes, ensuring the bottom of lower bends are at least 1-1/2 inch from the ground.
4. Pour concrete and level rack.
5. Support until dry.

3.04 CLEANING

- A. Clean installed work to like-new condition. Do not use cleaning materials or methods that could damage finish.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

Section 02911

TOPSOIL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and placing topsoil for finish grading and for seeding, sodding, and planting.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for topsoil under this Section. Include payment in Section 02921 - Hydro-mulch Seeding or Section 02922 - Sodding.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Topsoil shall be fertile, friable, natural sandy loam surface soil obtained from excavation or borrow operations having following characteristics:
 - 1. pH value of between 5.5 and 6.5
 - 2. Liquid limit: 50 or less
 - 3. Plasticity index: 20 or less
 - 4. Gradation: maximum of 10 percent passing No. 200 sieve
- B. Topsoil shall be reasonably free of subsoil, clay lumps, weeds, non-soil materials, and other litter or contamination. Topsoil shall not contain roots, stumps, and stones larger than 2 inches.

- C. Obtain topsoil from naturally well-drained areas where topsoil occurs at minimum depth of 4 inches and has similar characteristics to that found at placement site. Do not obtain topsoil from areas infected with growth of, or reproductive parts of nut grass or other noxious weeds.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Excavate topsoil for esplanades and areas to receive grass or landscaping from areas to be further excavated. Stockpile in area approved by Project Manager.
- B. Stockpile topsoil to depth not exceeding 8 feet. Cover to protect from erosion.

3.02 TOPSOIL EXCAVATION

- A. Conform to excavation and stockpiling requirements of Section 02315 - Roadway Excavation.

3.03 PLACEMENT

- A. Place no topsoil until subgrade has been approved. For areas to be seeded or sodded, scarify or plow existing material to minimum depth of 4 inches, or as indicated on Drawings. Remove vegetation and foreign inorganic material. Place 4 inches of topsoil on loosened material and roll lightly with appropriate lawn roller to consolidate topsoil.
- B. Increase depth of topsoil to 6 inches when placed over sand bedding and backfill materials specified in Section 02320 - Utility Backfill Material.
- C. For areas to receive shrubs or trees, excavate existing material and place topsoil to depth and dimensions shown on Drawings.
- D. Remove spilled topsoil from curbs, gutters, and, paved areas and dispose of excess topsoil in accordance with requirements of Section 01576 - Waste Material Disposal.
- E. Place topsoil to promote good drainage and compact with light roller. Water topsoil after placement until saturated for minimum depth 6 inches, fill in and recompact areas of settlement.

3.04 PROTECTION

- A. Protect topsoil from wind and water erosion until planting is completed.

END OF SECTION

Section 02912

TREE, PLANT, AND HARDSCAPE PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section includes:

1. Tree root barriers; various depths and combinations may be required.
2. Tree trunk protectors.
3. Water barriers.
4. Staking and guying materials.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for root barrier shall be on a linear foot basis for height noted.
2. Payment for tree trunk protector, water barriers and staking material shall be on a linear foot basis for height noted.
3. Refer to Section 01270-Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). When Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. Standards of the following as referenced:

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).

1.04 DEFINITIONS

A. Terms:

1. Tree root barrier: Mechanical barrier and root deflector to prevent tree roots from damaging hardscapes and landscapes.
2. Tree trunk protector: Material to protect young tree trunks from rodents, string trimmers, and lawn mowers.
3. Water barriers:
 - a. Controls run-off, preventing hardscape damage.
 - b. Prevents irrigation water from percolating under pavement.
 - c. Water corral for planting areas preventing pavement damage and saves water.
 - d. Prevents snow, ice, and saltwater run-off from polluting planting areas adjacent to roadways and parking areas.
 - e. Liner to separate golf greens and turf.
 - f. Bamboo control.

1.05 SUBMITTALS

- A. Product data: Manufacturers standard literature defining materials for use on this Project.
- B. Shop drawings:
 1. Indicate locations and extent for tree root barrier material.
 2. Indicate trees receiving tree trunk protectors.
 3. Indicate locations and extent of water barriers.
 4. Indicate trees and plants to be staked and guyed.
- C. Samples; if required by Architect:
 1. Tree root barrier: One full length panel.
 2. Tree trunk protector: One unit.
 3. Water barrier: One lineal foot of material.
 4. Staking and guying: One lineal foot.
- D. Quality control submittals; manufacturer's instructions: Complete installation instructions for

each item specified; may be combined with product data.

1.06 QUALITY ASSURANCE

- A. Qualifications; manufacturer: Minimum 20 years experience in tree and plant protection and accessories.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packing and shipping: Provide materials in original unopened containers with manufacturer's labels intact and legible.
- B. Acceptance at site:
 - 1. Damaged materials determined by visual inspection will not be accepted.
 - 2. Remove rejected materials from Project site immediately.
- C. Storage and protection: Store materials in dry area in manufacturer's protective packaging; in original containers with labels and instruction instructions intact.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Acceptable manufacturers:
 - 1. Products of manufacturers meeting indicated standards and specified material properties are acceptable for use, subject to approval of product list and samples.
- B. Basic Material Properties of Tree Root Barriers

Material and Thickness		Homopolymer Polyethylene
Properties	ASTM Test Method	Value Homopolymer Polyethylene
Tensile Stress Yield	D638	3800
Elongation at Break %	D638	10%
Tensile Modulus	D638	155,000
Notched Izod Impact	D256A	0.4 – 0.4
Flexural Modulus 73 PSI	0790	145,000
Hardness Shore	D2240	P66

2.02 MANUFACTURED UNITS

- A. Tree root barriers:
- a) Shall be produced 12” – 48” depth.
 - b) Material: 0.080” wall thickness, nominal, injection molded 50% post-consumer recycled polypropylene panels with UV inhibitors.
 - c) Panel Specifics:
 1. 7/16” Wide integral molded 0.08” thickness double top edge with stiffening ribs; bottom edge attached to vertical root deflecting ribs.
 2. Integral molded 0.080” thickness by 2” deep vertical root directing ribs spaced at 6.0” O.C.
 3. Integral molded 0.080” thickness by 2” long by 3/8” wide horizontal anti-lift ground lock tabs; minimum three per panel.
 - d) Preassembled joiner system for panel connection to adjacent panel.
 - e) Refer to standard details for root barrier installation.

- B. Tree trunk protectors:
1. Material: 0.060” thickness polyethylene with UV inhibitors, recyclable.
 2. Size: 9” high by single length accommodating tree up to 4” dia.
 3. Larger trees indicated for protection: Couple two or more sections together.

- C. Water barriers:
1. Product standard of quality: Water Barrier WB Series.
 2. Material: 0.030" 0.040" thickness High Density Polyethylene (HPDE).
 3. Sizes: 24", 30", and 36" wide by 300'-0" rolls.
 4. Manufacturers standard sealing tape.
 5. Sealant: Silicone type recommended by water barrier manufacturer for certain applications; applications requiring sealant indicated in manufacturers product data.

- D. Staking and guying materials:
1. Material: Flat, woven polypropylene; 900 lb. break strength.
 2. Size: wide by manufacturers standard roll lengths.

2.03 ACCESSORIES

- A. Provide related materials for complete installation of specified materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:

1. Verify other work in other sections, in, at, and around landscaping work is complete to extent that no damage will occur to newly planted materials or, any possible construction related damage will be minimal and replacement plant material is readily available for planting at no additional cost.
2. Obtain verification, in writing, from work required in other Sections directly involving work in this Section regarding correct grades have been provided, coordination of topsoil spreading, and lawns and grasses planting.
3. The contractor shall fulfill the responsibilities below prior to beginning work. Failure to do so will require removal or replanting work in this section.
 - a. Provide written notification to Architect of unacceptable conditions
 - b. Receive verification of written notice

3.02 PREPARATION

- A. Surface protection: Use methods necessary to prevent damage to completed site work performed in other Sections. Protect access to and areas around planted materials. Restore damaged areas to original compaction, grades, and lines; repair damaged grassed areas.

3.03 INSTALLATION

- A. Tree root barriers: Install in accord with manufacturers reviewed installation instructions where indicated on reviewed shop drawings with vertical root directing ribs facing inwards towards trees or plants; connect panels together as required.
- B. Tree trunk protectors:
1. Install in accord with manufacturers reviewed installation instructions where indicated on reviewed shop drawings.
 2. Join two or more segments together for trees over 4" dia.
- C. Water barriers:
1. Install where indicated on reviewed shop drawings in accord with manufacturers reviewed installation instructions using material widths required for conditions encountered.

2. Seal to hardscape surfaces with specified sealant.
3. Join material lengths with manufacturers sealing tape.

D. Staking and guying materials:

1. Immediately after planting, guy and stake designated trees and large plants.
2. Include tightening of guying materials to bring trees and plants to upright position.

END OF SECTION

Section 02915

TREE PLANTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Street right-of-way tree planting and maintenance.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. Payment for tree planting is on unit price basis for each tree planted.
2. When shown on Drawings or directed by Project Manager to remove and relocate tree affected by trench zone, work shall be paid for under one of the following bid items.
 - a. Bid item "Remove and Relocate Tree" includes moving tree with truck mounted tree spade and replanting same tree in new location. Payment is for each tree removed and relocated.
 - b. Bid item "Remove, Temporary Store and Replant Tree" includes moving tree with truck mounted tree spade and replanting tree at temporary location, (determined by Contractor) maintaining tree until construction is complete and replanting same tree back to its original location. Payment is for each tree removed, stored and replanted.
3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ANSI Z 60.1 - Nursery Stock.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certification from supplier that each type of tree conforms to these specification requirements.

- C. For unpackaged materials, submit analysis by recognized laboratory made in accordance with methods established by Association of Official Agriculture Chemists, when applicable.
- D. Submit name and experience of qualified Arborist to Project Manager.
- E. Submit temporary tree storage location. Location must be outside public right-of-way and within 5 miles of project site, unless otherwise approved by Project Manager.

1.05 QUALITY ASSURANCE

- A. Landscaper shall be a firm specializing in landscape and planting work.
- B. Do not make substitutions of approved trees unless approved in writing by Project Manager. When specified planting material is not obtainable, submit proof of non-availability together with proposal for use of equivalent material. Substitutions of larger size or better grade than specified will be allowed, but with no increase in unit price.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship trees with Certificates of Inspection as required by governing authorities. Label each tree and shrub with securely attached waterproof tag bearing legible designation of botanical and common name. Do not remove container grown stock from containers before time of planting.
- B. Deliver packaged materials in fully labeled original containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at Site.
- C. Materials shall not be pruned prior to installation unless approved by Project Manager in writing. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches, or destroy natural shape. Use protective covering during delivery.

1.07 WARRANTY

- A. Warrant trees against defects including death, unsatisfactory growth, or loss of shape due to improper pruning, maintenance, or weather conditions, for 1 year after completion of planting. Plumb leaning trees during warranty period.
- B. Remove and replace trees found to be dead during warranty period. Remove and replace trees which are in doubtful condition at end of warranty period, or when approved by Project Manager, extend warranty period for trees for full growing season.

PART 2 PRODUCTS

2.01 TREES

- A. Provide container grown trees which are straight and symmetrical and have persistently preferred main leader. Crown shall be in good overall proportion to entire height of tree with branching configuration as recommended by ANSI Z60.1 for type and species specified. Where clump is specified, furnish plant having minimum of three stems originating from common base at ground line. Measure trees by average caliper of trunk as follows:
1. For trunks up to 4 inches or less in diameter, measure caliper 6 inches above top of root ball.
 2. For trunks more than 4 inches, measure caliper 12 inches above top of root ball.
 3. Caliper measurements shall be by diameter tape measure. Indicated calipers on plans are minimum. Averaging of plant calibers will not be allowed.
- B. Trees shall conform to following requirements:
1. Healthy, vigorous stock, grown in recognized nursery.
 2. Free of disease, insects, eggs, larvae; and free of defects such as knots, sun-scald, injuries, abrasions, disfigurement, or borers and infestations.

2.02 SOIL PRODUCTS

- A. Topsoil: Conform to requirements of Section 02911 - Topsoil.
- B. Peat moss, bark, and fertilizer: Use material recommended by nursery for establishment of healthy stock after replanting.

2.03 STAKES AND GUYS

- A. Provide minimum 8-foot long steel T-stakes and 1 inch wide plastic tree chains.
- B. Where applicable for anchoring trees, use wood deadmen of at least 2 by 4 stock, 36 inches long and buried 3 feet. Provide white surveyor's plastic tape for flagging tree guys.

2.04 TREE WRAP, TWINE, AND SEAL

- A. Wrap: First quality, bituminous impregnated tape, corrugated or crepe paper, specifically manufactured for tree wrapping and having qualities to resist insect infestation.

- B. Twine: Lightly tarred, medium-coarse sisal (lath) yarn. Do not use nails or staples to fasten wrapping.
- C. Seal: Commercially available asphaltic-base black emulsion specifically produced for use in sealing tree cuts and wounds.

2.05 WATER

- A. Water shall be potable from municipal water supplies.

2.06 SOURCE QUALITY CONTROL

- A. Notify Project Manager, prior to installation, of location where trees that have been selected for planting may be inspected. Plant material will be inspected for compliance with following requirements.
 - 1. Genus, species, variety, size and quality.
 - 2. Size and condition of balls and root systems, insects, injuries and latent defects.

PART 3 EXECUTION

3.01 PREPARATION

- A. Schedule work so that planting can proceed rapidly as portions of site become available. Plant trees after final grades are established and prior to planting of lawns, unless otherwise approved by Project Manager in writing. When planting of trees occurs after seeding work, protect lawn areas and promptly repair damage to lawns resulting from tree planting operations.
- B. Layout individual trees at locations shown on Drawings. In case of conflicts, notify Project Manager before proceeding with Work. Trees shall be staked and approved by Project Manager prior to planting.

3.02 PREPARATION OF PLANTING SOIL

- A. Before mixing, clean topsoil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
- B. Strip and utilize 4 inch layer of top soil, placed on esplanades under Section 02921 - Hydro-mulch Seeding, for planting soil mixture.

- C. Mix recommended soil amendments with topsoil at following rates:
 - 1. Top soil: 50 percent.
 - 2. Peat moss: 25 percent.
 - 3. Well rotted Bark: 25 percent.
 - 4. Fertilizer: Rate recommended by nursery.
- D. Delay mixing of fertilizer when planting will not follow placing of planting soil within 48 hours, unless otherwise directed.
- E. Incorporate amendments into soil as part of soil preparation process prior to fine grading, fertilizing, and planting. Broadcast or spread amendments evenly at specified rate over planting area. Thoroughly incorporate amendments into top 3 or 4 inches of soil until amendments are pulverized and have become homogeneous layer of topsoil ready for planting.

3.03 PLANTING

- A. Excavate pits, beds, or trenches with vertical sides and with bottom of excavation raised minimum of 6 inches at center for proper drainage. Provide following minimum widths:
 - 1. 15 gallon containers or larger, 2 feet wider than diameter of root ball.
 - 2. 1 and 5 gallon containers, 6 inches wider than diameter of root ball.
- B. When conditions detrimental to plant growth are encountered, such as unsatisfactory soil, obstructions, or adverse drainage conditions, notify Project Manager before planting.
- C. Deliver trees after preparations for planting have been completed and plant immediately. When planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap, or other acceptable means of retaining moisture, and water as needed.
- D. Set root ball on undisturbed soil in center of pit or trench and plumb plant. Place plants at level that, after settlement, natural relationship of plant crown with ground surface will be established.
- E. When set, place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

- F. Dish top of backfill to allow for mulching. Mulch pits, trenches and planted areas. Provide not less than 4 inch thickness of mulch, work into top of backfill, and finish level with adjacent finish grades. Cover entire root ball.
- G. Prune, thin out and shape trees in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed in writing, do not cut tree leaders, and remove only injured and dead branches from flowering trees. Remove and replace excessively pruned or misformed stock resulting from improper pruning.
- H. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures.
- I. Guy and stake trees immediately after planting.
- J. Control dust caused by planting operations. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

3.04 FIELD QUALITY CONTROL

- A. Project Manager may reject unsatisfactory or defective material at anytime during progress of Work. Remove rejected trees immediately from site and replace with specified materials. Plant material not installed in accordance with these Specifications will be rejected.
- B. An inspection to determine final acceptance will be conducted by Project Manager at end of 12 month maintenance period. Additional inspections will be conducted for extended warranty periods provided for in paragraph 1.07B.

3.05 MOVING EXISTING TREES

- A. Perform tree moving and replanting by a professional Arborist during dormant growth season.
- B. Provide tree spade of adequate size as directed by professional Arborist.

3.06 MAINTENANCE

- A. Maintain trees during planting operations and for period of 12 months after completion of planting.
- B. Water trees to full depth minimum of once each week, or as required to maintain healthy vigorous growth.

- C. Prune, cultivate, and weed as required for healthy growth. Restore planting saucers. Tighten and repair stake and guy supports, and reset trees and shrubs to proper grades or vertical position as required. Restore or replace damaged wrappings. Spray as required to keep trees and shrubs free of insects and disease.

3.07 CLEANUP AND PROTECTION

- A. During planting work, keep pavements clean and work area in orderly condition.
- B. Protect planting work and materials from damage due to planting operations. Maintain protection during installation and maintenance period. Treat, repair, or replace damaged planting work as directed by Project Manager.
- C. Dispose of excess soil and waste in accordance with requirements of Section Waste 01576 - Waste Material Disposal. On-site burning of combustible cleared materials will not be permitted.

END OF SECTION

Section 02921

HYDRO MULCH SEEDING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Seeding, fertilizing, mulching, and maintenance of areas indicated on Drawings.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for hydro mulch seeding is on an acre basis.
 - 2. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit certification from supplier that each type of seed conforms to these specifications and requirements of Texas Seed Law. Certification shall accompany seed delivery.
- C. Submit certificate stating that fertilizer complies with these specifications and requirements of Texas Fertilizer Law.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Topsoil: Conform to material requirements of Section 02911 - Topsoil.
- B. Seed: Conform to U.S. Department of Agriculture rules and regulations of Federal Seed Act and Texas Seed Law. Seed shall be certified 90 percent pure and furnish 80 percent germination and meet following requirements:

1. Rye: Fresh, clean, Italian rye grass seed (*lohium multi-florum*), mixed in labeled proportions. As tested, minimum percentages of impurities and germination must be labeled. Deliver in original unopened containers.
2. Bermuda: Extra-fancy, treated, lawn type common bermuda (*Cynodon dactylon*). Deliver in original, unopened container showing weight, analysis, name of vendor, and germination test results.
3. Wet, moldy, or otherwise damaged seed will not be accepted.
4. Seed requirements, application rates, and planting dates are:

TYPE	APPLICATION RATE POUNDS/A	PLANTING DATE
Hulled Common Bermuda Grass 98/88	40	Jan 1 to Mar 31
Unhulled Common Bermuda Grass 98/88	40	
Hulled Common Bermuda Grass 98/88	40	Apr 1 to Sep 30
Hulled Common Bermuda Grass 98/88	40	Oct 1 to Dec 31
Unhulled Common Bermuda Grass 98/88	40	
Annual Rye Grass (Gulf)	30	

- C. Fertilizer: Dry and free flowing, inorganic, water soluble commercial fertilizer, which is uniform in composition. Deliver in unopened containers which bear manufacturers guaranteed analysis. Caked, damaged, or otherwise unsuitable fertilizer will not be accepted. Fertilizer shall contain minimum percentages of following elements:

1. Nitrogen: 10 Percent
2. Phosphoric Acid: 20 Percent
3. Potash: 10 Percent

D. Mulch:

1. Virgin wood cellulose fibers from whole wood chips having minimum of 20 percent fibers 0.42 inches in length and 0.01 inches in diameter.
2. Cellulose fibers manufactured from recycled newspaper and meeting same fiber content and size as for cellulose fibers from wood chips.
3. Dye mulch green for coverage verification purposes.

- E. Soil Stabilizer: "Terra Tack 1" or approved equal.
- F. Weed control agent: Pre-emergent herbicide for grass areas, such as "Benefin," or approved equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Place and compact topsoil in accordance with requirements of Section 02911 - Topsoil.
- B. Dispose of Objectionable and Waste Materials in accordance with Section 01576 - Waste Material Disposal.

3.02 APPLICATION

- A. Seed: Apply uniformly at rates given in Paragraph 2.01 B for type of seed and planting date.
- B. Fertilizer: Apply uniformly at rate of 500 pounds per acre.
- C. Mulch: Apply uniformly at rate of 50 pounds per 1000 square feet.
- D. Soil Stabilizer: Apply uniformly at rate of 40 pounds per acre.
- E. Weed Control Agent: Apply at manufacturer's recommended rate prior to hydro mulching.
- F. Sod: Lay single row of sod along perimeter where top soil and pavement intersect. Apply in conformance to Section 02922 - Sodding.
- G. Suspend operations under conditions of drought, excessive moisture, high winds, or extreme or prolonged cold. Obtain Project Manager approval before resuming operations.

3.03 MAINTENANCE

- A. Maintain grassed areas minimum of 90 days, or as required to establish an acceptable lawn. For areas seeded in fall, continue maintenance following spring until acceptable lawn is established.
- B. Maintain grassed areas by watering, fertilizing, weeding, and trimming.
- C. Repair areas damaged by erosion by regrading, rolling and replanting.
- D. Reseed small, sparse grass areas. When sparse areas exceed 20 percent of planted area, reseed by hydro mulch.

- E. Mow grass when height reaches 3 1/2 inches or greater on average before final acceptance.
Mow to height of 2 1/2 inches.

END OF SECTION

Section 02922

SODDING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Restoration of existing lawn areas disturbed by construction shall be by installation of new sod.
- B. Planting of sod within areas designated on Drawings for purpose of surface stabilization, channel stabilization or vegetation buffer strips.
- C. Sod is defined as blocks, squares, strips of turfgrass, and adhering soil used for vegetative planting. To be placed edge to edge for complete coverage.
- D. Lawn is defined as ground covered with fine textured grass kept neatly mowed.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for sodding is on square yard basis.
 - 2. For utility construction, no separate payment will be made for sodding. Include payment in section 01740 under site restoration.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.

1.04 QUALITY ASSURANCE

- A. Sod only when weather and soil conditions are deemed by Project Manager to be suitable for proper placement.
- B. Water and fertilize new sod.
- C. Guarantee sod to be growing 30 days after substantial completion.

D. Maintenance Period:

1. Begin maintenance immediately after each section of grass sod is installed and continue for 30 day period from date of substantial completion.
2. Resod unacceptable areas.
3. Water, fertilize, control disease and insect pests, mow, edge, replace unacceptable materials, and perform other procedures consistent with good horticultural practice to ensure normal, vigorous and healthy growth. Install disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.

E. Notify Project Manager 10 days before end of maintenance period for inspection.

PART 2 PRODUCTS

2.01 SOD

- A. Species: Bermuda (*Cynodon Dactylon*), Buffalo (*Buchloe Dactyloides*), or St. Augustine (*Stenotaphrum Secundatum*) Gulf Coast variety to match existing sod.
- B. Contents: 95 percent permanent grass suitable to climate in which it is to be placed; not more than 5 percent weeds and undesirable grasses; good texture, free from obnoxious grasses, roots, stones and foreign materials.
- C. Size: 12 inch wide strips, uniformly 2 inches thick with clean-cut edges.
- D. Sod is to be supplied and maintained in healthy condition as evidenced by grass being normal green color.

2.02 FERTILIZER

- A. Available nutrient percentage by weight: 12 percent nitrogen, 4 percent phosphoric acid, and 8 percent potash; or 15 percent nitrogen, 5 percent phosphoric acid, and 10 percent potash.

2.03 WEED AND INSECT TREATMENT

- A. Provide acceptable treatment to protect sod from weed and insect infestation. Submit treatment method to Project Manager for approval. Install insect and disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.

2.04 WATER

- A. Potable, available on-site through Contractor's water trucks. Contractor may use City of Houston hydrants when water use is measured through Contractor's meter. Do not use private resident's water.

2.05 BANK SAND

- A. Free of clay lumps, roots, grass, salt or other foreign material.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that soil placement and compaction have been satisfactorily completed. Verify that soil is within allowable range of moisture content.
- B. Top soil shall be free of weeds and foreign material immediately before sodding.
- C. Do not start work until conditions are satisfactory. Do not start work during inclement or impending inclement weather.
- D. Rake areas to be sodded smooth, free from unsightly variations, bumps, ridges or depressions.
- E. Spread 2 inch layer of bank sand over areas to be sodded prior to planting of sod.
- F. Apply fertilizer at rate of 25 pounds per 1000 square feet. Apply after raking soil surface and not more than 48 hours prior to laying sod. Mix thoroughly into upper 2 inches of soil. Lightly water to aid in dissipation of fertilizer.

3.02 APPLICATION

- A. Full Sodding: Lay sod with closely fitted joints leaving no voids and with ends of sod strips staggered. Lay sod within 24 hours of harvesting.
- B. On slopes 2:1 and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.
- C. Prior to placing sod, on slopes 3:1 or where indicated, place Hold/Gro or Roll Lite or equal over topsoil. Securely anchor in place with posts sunk firmly into ground at maximum 16 feet on center along pitch of slope and equal to width of wire mesh horizontally across slopes.
- D. After sod is laid, irrigate thoroughly to secure 6-inch minimum penetration into soil below sod.

- E. Tamp and roll sod with approved equipment to eliminate minor irregularities and to form close contact with soil bed immediately after planting and watering. Submit type of tamping and rolling equipment to be used to Project Manager for approval, prior to construction.

3.03 MAINTENANCE

A. Watering:

1. Water lawn areas once a day with minimum 1/2 inch water for first 3 weeks after area is sodded.
2. After 3 week period, water twice a week with 3/4 inch of water each time unless comparable amount has been provided by rain.
3. Make weekly inspections to determine moisture content of soil unless soil is in frozen condition.
4. Water in afternoon or at night to enable soil to absorb maximum amount of water with minimum evaporation.

B. Mowing:

1. Mow sod at intervals which will keep grass height from exceeding 3 1/2 inches.
2. Set mower blades at 2 1/2 inches.
3. Do not remove more than one-half of grass leaf surface.
4. Mow sodded areas requiring mowing within 1 month after installation with light-weight rotary type mower. Mow sod only when dry and not in saturated or soft condition.
5. Remove grass clippings during or immediately after mowing.

C. Fertilizer and Pest Control:

1. Evenly spread fertilizer composite at rate of 40 pounds per 5000 square feet or as recommended by manufacturer. Do not place fertilizer until 2 weeks after placement of sod.
2. Restore bare or thin areas by topdressing with mix of 50 percent sharp sand and 50 percent sphagnum peat moss.
3. Apply mixture 1/4 to 1/2 inch thick.

4. Treat areas of heavy weed and insect infestation as recommended by treatment manufacturer.
 - D. Restrict all traffic from sodded areas until sod is established or for minimum 10 days during growing season. Use wood lath and plastic tape to cordon sodded areas. Maintain tape and lath throughout for minimum 30 days during growing season.
- 3.04 CLEANUP
- A. During course of planting, remove excess and waste materials; keep lawn areas clean and take precautions to avoid damage to existing structures, plants, grass, and streets.
 - B. Remove barriers, signs, and other Contractor material and equipment from project site at termination of establishment period.
 - C. Dispose of unused materials and rubbish in accordance with Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02951

PAVEMENT REPAIR AND RESTORATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Repairing and replacing streets, highways, and other pavements as required per street cut ordinance that have been cut, broken, or damaged due to utility excavation.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for pavement repair and replacement for utility projects is on a square yard basis and includes surface and base materials as required per street cut ordinance.
 - 2. Measurement for utility projects: Match actual pavement replaced but no greater than maximum pavement replacement limits in accordance with the street cut ordinance or otherwise shown on drawings.
 - 3. Refer to Section 01270 - Measurement and Payment for other unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this section is included in total Stipulated Price.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Subgrade:
 - 1. Provide backfill material as required by applicable excavation and fill sections (Sections 02315 through 02319) and Section 02330 - Embankment.
 - 2. Provide material for stabilization as required by applicable portions of Section 02336 - Lime Stabilized Subgrade, Section 02337 - Lime/Fly-Ash Stabilized Subgrade, and Section 02338 - Portland Cement Stabilized Subgrade.
- B. Base: Provide base material as required by applicable portions of Section 02711 - Hot Mix Asphaltic Base Course, Section 02712 - Cement Stabilized Base Course, and Section 02713 - Crushed Concrete Base Course.

- C. Pavement: Provide paving materials as required by applicable portions of Section 02741 - Asphaltic Concrete Pavement, Section 02751- Concrete Paving, Section 02754 - Concrete Driveways, and Section 02771 - Curb, Curb and Gutter, and Headers, and Section 02775 - Concrete Sidewalks.

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify City prior to commencement of excavation in pavement for which an Excavation in Public Way permits has been obtained. Follow directions contained in the permit.
- B. Conform to requirement of Section 02221 - Removing Existing Pavements and Structures, for removals.
- C. Saw cut pavement 18 inches wider than width of trench needed to install utilities unless otherwise indicated on Drawings.
- D. When removing pavement to existing deformed metal strip (i.e. dummy joint), saw cut pavement minimum 2 inches deep on opposite side of deformed metal strip. Place saw joint far enough behind deformed metal strip to obtain continuously straight joint. Remove damaged portion of deformed metal strip as required to provide proper joint. Saw cut and remove metal strip before placement of new concrete pavement.
- E. Protect edges of existing pavement to remain from damage during removals, utility placement, backfill, and paving operations. For concrete pavement, protect undisturbed subgrade that is to remain to support replacement slab.
- F. Dowel in existing pavement where no reinforcement is found or is broken due to construction activities. Unless otherwise directed by Project Manager, provide No. 6 bars 24 inches long, drilled and embedded 8 inches into center of existing slab with 'PO-ROC' epoxy grout or approved equal. Space dowels to match new pavement reinforcement spacing.
- G. Provide transitional paving and earthwork as required to tie proposed pavement to existing pavement when unable to dowel new pavement into existing pavement.

3.02 INSTALLATION

- A. Parking Areas, Service Drives, Driveways, and Sidewalks: Replace with material equal to or better than existing or as indicated on Drawings. Conform to applicable requirements of sections referenced in Paragraph 2.01, Materials.

- B. Street Pavements and Curbs, Curbs and Gutters: Replace subgrade, base, and surface course with like materials or as indicated on Drawings and City of Houston Standard Detail 02951.01. Curbs and curbs and gutters shall match existing. Conform to requirements of sections referenced in Paragraph 2.01, Materials.
- C. For concrete pavement, install size and length of reinforcing steel and pavement thickness indicated on Drawings and City of Houston Standard Detail 02751.01. Place types and spacing of joints to match existing or as indicated on Drawings.
- D. Where existing pavement consists of concrete pavement with asphaltic surfacing, resurface with minimum 2 inch depth asphaltic pavement.
- E. Repair state highway and county crossings in accordance with TxDOT permit or county requirements as appropriate and within 1 week after utility work is installed.

3.03 WASTE MATERIAL DISPOSAL

- A. Dispose of waste material in accordance with requirements of Section 01576 - Waste Material Disposal.

3.04 PROTECTION

- A. Maintain pavement in good condition until completion of Work.
- B. Replace pavement damaged by Contractor's operations at no cost to City.

END OF SECTION

Section 03315

CONCRETE FOR UTILITY CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cast-in-place concrete work for utility construction or rehabilitation, such as slabs on grade, small vaults, site-cast bases for precast units, and in-place liners for manhole rehabilitation.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for concrete for utility construction under this Section. Include cost in applicable utility structure.
 - 2. Obtain services of and pay for certified testing laboratory to prepare design mixes.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
- C. ACI 302.1R - Guide for Concrete Floor and Slab Construction.
- D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- E. ACI 308 - Standard Practice for Curing Concrete.
- F. ACI 309R - Guide for Consolidation of Concrete.
- G. ACI 311 - Guide for Concrete Plant Inspection and Field Testing of Ready-Mix Concrete.
- H. ACI 315 - Details and Detailing of Concrete Reinforcement.

- I. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary.
- J. ACI 544 - Guide for Specifying, Mixing, Placing, and Finishing Steel Fiber Reinforced Concrete.
- K. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- L. ASTM A 185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- M. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- N. ASTM A 767 - Standard Specifications for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
- O. ASTM A 775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
- P. ASTM A 820 - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.
- Q. ASTM A 884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
- R. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- S. ASTM C 33 - Standard Specification for Concrete Aggregates.
- T. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- U. ASTM C 42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- V. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- W. ASTM C 138 - Standard Test Method for Unit Weight Yield and Air Content (Gravimetric) of Concrete.
- X. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- Y. ASTM C 150 - Standard Specification for Portland Cement.
- Z. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.

- AA. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method.
- AB. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- AC. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- AD. ASTM C 309 - Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.
- AE. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
- AF. ASTM C 595 - Standard Specification for Blended Hydraulic Cements.
- AG. ASTM C 685 - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
- AH. ASTM C 1064 - Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
- AI. ASTM C 1077 - Standard Practice for Laboratory Testing of Concrete and Concrete Aggregate for Use in Construction and Criteria for Laboratory Evaluation.
- AJ. CRSI MSP-1 - Manual of Standard Practice.
- AK. CRSI - Placing Reinforcing Bars.
- AL. Federal Specification SS-S-210A - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints
- AM. NRMCA - Concrete Plant Standards.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed mix design and test data for each type and strength of concrete in Work.
- C. Submit laboratory reports prepared by independent testing laboratory stating that materials used comply with requirements of this Section.
- D. Submit manufacturer's mill certificates for reinforcing steel. Provide specimens for testing when required by Project Manager.

- E. Submit certification from concrete supplier that materials and equipment used to produce and deliver concrete comply with this Specification.
- F. When required on Drawings, submit shop drawings showing reinforcement type, quantity, size, length, location, spacing, bending, splicing, support, fabrication details, and other pertinent information.
- G. For waterstops, submit product information sufficient to indicate compliance with this Section, including manufacturer's descriptive literature and specifications.

1.05 HANDLING AND STORAGE

- A. Cement: Store cement off of ground in well-ventilated, weatherproof building.
- B. Aggregate: Prevent mixture of foreign materials with aggregate and preserve gradation of aggregate.
- C. Reinforcing Steel: Store reinforcing steel to protect it from mechanical injury and formation of rust. Protect epoxy-coated steel from damage to coating.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Cementitious Material:
 - 1. Portland Cement: ASTM C 150, Type II, unless use of Type III is authorized by Project Manager; or ASTM C 595, Type IP. For concrete in contact with sewage use Type II cement.
 - 2. When aggregates are potentially reactive with alkalis in cement, use cement not exceeding 0.6 percent alkali content in form of $\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$.
- B. Water: Clean, free from harmful amounts of oils, acids, alkalis, or other deleterious substances, and meeting requirements of ASTM C 94.
- C. Aggregate:
 - 1. Coarse Aggregate: ASTM C 33. Unless otherwise indicated, use following ASTM standard sizes: No. 357 or No. 467; No. 57 or No. 67, No. 7. Maximum size: Not larger than 1/5 of narrowest dimension between sides of forms, nor larger than 3/4 of minimum clear spacing between reinforcing bars.
 - 2. Fine Aggregate: ASTM C 33.

3. Determine potential reactivity of fine and coarse aggregate in accordance with Appendix to ASTM C 33.
- D. Air Entraining Admixtures: ASTM C 260.
- E. Chemical Admixtures:
1. Water Reducers: ASTM C 494, Type A.
 2. Water Reducing Retarders: ASTM 494, Type D.
 3. High Range Water Reducers (Superplasticizers): ASTM C 494, Types F and G.
- F. Prohibited Admixtures: Admixtures containing calcium chloride, thiocyanate, or materials that contribute free chloride ions in excess of 0.1 percent by weight of cement.
- G. Reinforcing Steel:
1. Use new billet steel bars conforming to ASTM A 615, ASTM A 767, or ASTM A 775, grade 40 or grade 60, as shown on Drawings. Use deformed bars except where smooth bars are specified. When placed in work, keep steel free of dirt, scale, loose or flaky rust, paint, oil or other harmful materials.
 2. Where shown, use welded wire fabric with wire conforming to ASTM A 185 or ASTM A 884. Supply gauge and spacing shown, with longitudinal and transverse wires electrically welded together at points of intersection with welds strong enough not to be broken during handling or placing.
 3. Wire: ASTM A 82. Use 16 1/2 gauge minimum for tie wire, unless otherwise indicated.
- H. Fiber:
1. Fibrillated Polypropylene Fiber:
 - a. Addition Rate: 1.5 pounds of fiber per cubic yard of concrete.
 - b. Physical Properties:
 1. Material: Polypropylene
 2. Length: 1/2 inch or graded
 3. Specific Gravity: 0.91
 - c. Acceptable Manufacturer: W. R. Grace Company, Fibermesh, or approved equal.

2. Steel Fiber: Comply with applicable provisions of ACI 544 and ASTM A 820.
 - a. Ratio: 50 to 200 pounds of fiber per cubic yard of concrete.
 - b. Physical Properties
 1. Material: Steel
 2. Aspect Ratio (for fiber lengths of 0.5 to 2.5 inch, length divided by diameter or equivalent diameter): 30:1 to 100:1
 3. Specific Gravity: 7.8
 4. Tensile Strength: 40-400 ksi.
 5. Young's Modulus: 29,000 ksi
 6. Minimum Average Tensile Strength: 50,000 psi
 7. Bending Requirements: Withstand bending around 0.125-inch diameter mandrel to angle of 90 degrees, at temperatures not less than 60 degrees F, without breaking
- I. Curing Compounds: Type 2 white-pigmented liquid membrane-forming compounds conforming to ASTM C 309.

2.02 FORM WORK MATERIALS

- A. Lumber and Plywood: Seasoned and of good quality, free from loose or unsound knots, knot holes, twists, shakes, decay and other imperfections which would affect strength or impair finished surface of concrete. Use S4S lumber for facing or sheathing. Forms for bottoms of caps: At least 2 inch (nominal) lumber or 3/4 inch form plywood backed adequately to prevent misalignment. For general use, provide lumber of 1-inch nominal thickness or form plywood of approved thickness.
- B. Form work for Exposed Concrete Indicated to Receive Rubbed Finish: Form or form-lining surfaces free of irregularities; plywood of 1/4 inch minimum thickness, preferably oiled at mill.
- C. Chamfer Strips and Similar Moldings: Redwood, cypress, or pine that will not split when nailed and which can be maintained to true line. Use mill-cut molding dressed on all faces.
- D. Form Ties: Metal or fiberglass of approved type with tie holes not larger than 7/8 inch in diameter. Do not use wire ties or snap ties.

- E. Metal Forms: Clean and in good condition, free from dents and rust, grease, or other foreign materials that tend to disfigure or discolor concrete in gauge and condition capable of supporting concrete and construction loads without significant distortion. Countersink bolt and rivet heads on facing sides. Use only metal forms which present smooth surface and which line up properly.

2.03 PRODUCTION METHODS

- A. Use either ready-mixed concrete conforming to requirements of ASTM C 94, or concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685.

2.04 MEASUREMENT OF MATERIALS

- A. Measure dry materials by weight, except volumetric proportioning may be used when concrete is batched and mixed in accordance with ASTM C 685.
- B. Measure water and liquid admixtures by volume.

2.05 DESIGN MIX

- A. Use design mixes prepared by certified testing laboratory in accordance with ASTM C 1077 and conforming to requirements of this section.
- B. Proportion concrete materials based on ACI 211.1 to comply with durability and strength requirements of ACI 318, Chapters 4 and 5, and this specification. Prepare mix design of Class A concrete so minimum cementitious content is 564 pounds per cubic yard. Submit concrete mix designs to Project Manager for review.
- C. Proportioning on basis of field experience or trial mixtures in accordance with requirements at Section 5.3 of ACI 318 may be used, when approved by Project Manager.
- D. Classification:

CLASS	TYPE	MINIMUM COMPRESSIVE STRENGTH (LBS/SQ. IN.)		MAXIMUM W/C RATIO	AIR CONTENT (PERCENT)	CONSISTENCY RANGE IN SLUMP (INCHES)
		7-DAY	28-DAY			
A	Structural	3200	4000	0.45	4± 1	2 to 4*
B	Pipe Block Fill, Thrust Block	----	1500	----	4± 1	5 to 7

*When ASTM C 494, Type F or Type G admixture is used to increase workability, this range may be 6 to 9.

- E. Add steel or polypropylene fibers only when called for on Drawings or in another section of these Specifications.
- F. Determine air content in accordance with ASTM C 138, ASTM C 173 or ASTM C 231.
- G. Use of Concrete Classes: Use classes of concrete as indicated on Drawings and other Specifications. Use Class B for unreinforced concrete used for plugging pipes, seal slabs, thrust blocks, trench dams, tunnel inverts and concrete fill unless indicated otherwise. Use Class A for all other applications.

2.06 PVC WATERSTOPS

- A. Extrude from virgin polyvinyl chloride elastomer. Use no reclaimed or scrap material. Submit waterstop manufacturer's current test reports and manufacturer's written certification that material furnished meets or exceeds Corps of Engineers Specification CRD-C572 and other specified requirements.
- B. Flat Strip and Center-Bulb Waterstops:
 - 1. Thickness: not less than 3/8 inch
 - 2. Acceptable Manufacturers:
 - a. Kirkhill Rubber Co., Brea, California
 - b. Water Seals, Inc., Chicago, Illinois
 - c. Progress Unlimited, Inc., New York, New York
 - d. Greenstreak Plastic Products Co., St. Louis, Missouri
 - e. Approved equal.

2.07 RESILIENT WATERSTOP

- A. Resilient Waterstop: Where shown on Drawings; either bentonite- or adhesive-type material.
- B. Bentonite Waterstop:
 - 1. Material: 75 percent bentonite, mixed with butyl rubber-hydrocarbon containing less than 1.0 percent volatile matter, and free of asbestos fibers or asphaltics.
 - 2. Manufacturer's rated temperature ranges: For application, 5 to 125 degrees F; in service, -40 to 212 degrees F.
 - 3. Cross-sectional dimensions, unexpanded waterstop: 1 inch by 3/4 inch

4. Provide with adhesive backing capable of producing excellent adhesion to concrete surfaces.
- C. Adhesive Waterstop:
1. Preformed plastic adhesive waterstop at least 2 inches in diameter.
 2. Meets or exceeds requirements of Federal Specification SS-S-210A.
 3. Supplied wrapped completely by 2 part protective paper.
 4. Submit independent laboratory tests verifying that material seals joints in concrete against leakage when subjected to minimum of 30 psi water pressure for at least 72 hours.
 5. Provide primer, to be used on hardened concrete surfaces, from same manufacturer who supplies waterstop material.
 6. Acceptable Manufacturer: Synko-Flex Preformed Plastic Adhesive Waterstop, Synko-Flex Products, Inc.; or approved equal.

PART 3 EXECUTION

3.01 FORMS AND SHORING

- A. Provide mortar-tight forms sufficient in strength to prevent bulging between supports. Set and maintain forms to lines designated such that finished dimensions of structures are within tolerances specified in ACI 117. Construct forms to permit removal without damage to concrete. Forms may be given slight draft to permit ease of removal. Provide adequate clean out openings. Before placing concrete, remove extraneous matter from within forms.
- B. Install rigid shoring having no excessive settlement or deformation. Use sound timber in shoring centering. Shim to adjust and tighten shoring with hardwood timber wedges.
- C. Design Loads for Horizontal Surfaces of Forms and Shoring: Minimum fluid pressure, 175 pounds per cubic foot; live load, 50 pounds per square foot. Maximum unit stresses: 125 percent of allowable stresses used for form materials and for design of support structures.
- D. Back form work with sufficient number of studs and wales to prevent deflection.
- E. Re-oil or lacquer liner on job before using. Facing may be constructed of 3/4 inch plywood made with waterproof adhesive backed by adequate studs and wales. In such cases, form lining will not be required.

- F. Unless otherwise indicated, form outside corners and edges with triangular 3/4 inch chamfer strips (measured on sides).
- G. Remove metal form ties to depth of at least 3/4 inch from surface of concrete. Do not burn off ties. Do not use pipe spreaders. Remove spreaders which are separate from forms as concrete is being placed.
- H. Treat facing of forms with approved form coating before concrete is placed. When directed by Project Manager, treat both sides of face forms with coating. Apply coating before reinforcement is placed. Immediately before concrete is placed, wet surface of forms which will come in contact with concrete.

3.02 PLACING REINFORCEMENT

- A. Place reinforcing steel accurately in accordance with approved Drawings. Secure steel adequately in position in forms to prevent misalignment. Maintain reinforcing steel in place using approved concrete and hot-dip galvanized metal chairs and spacers. Place reinforcing steel in accordance with CRSI Publication "Placing Reinforcing Bars." Request inspection of reinforcing steel by Project Manager and obtain acceptance before concrete is placed.
- B. Minimum spacing center-to-center of parallel bars: 2 1/2 times nominal bar diameter. Minimum cover measured from surface of concrete to face of reinforcing bar unless shown otherwise on Drawings: 3 inches for surfaces cast against soil or subgrade, 2 inches for other surfaces.
- C. Detail bars in accordance with ACI 315. Fabricate reinforcing steel in accordance with CRSI Publication MSP-1, "Manual of Standard Practice." Bend reinforcing steel to required shape while steel is cold. Excessive irregularities in bending will be cause for rejection.
- D. Do not splice bars without written approval of Project Manager. Approved bar bending schedules or placing drawings constitute written approval. Splice and development length of bars shall conform to ACI 318, Chapters 7 and 12, and as shown on Drawings. Stagger splices or locate at points of low tensile stress.

3.03 EMBEDDED ITEMS

- A. Install conduit and piping as shown on Drawings. Accurately locate and securely fasten conduit, piping, and other embedded items in forms.
- B. Install waterstops as specified in other sections and according to manufacturer's instructions. Securely position waterstops at joints as indicated on Drawings. Protect waterstops from damage or displacement during concrete placing operations.

3.04 BATCHING, MIXING AND DELIVERY OF CONCRETE

- A. Measure, batch, mix, and deliver ready-mixed concrete in accordance with ASTM C 94, Sections 8 through 11. Produce ready-mixed concrete using automatic batching system as described in NRMCA Concrete Plant Standards, Part 2 - Plant Control Systems.
- B. Measure, mix and deliver concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685, Sections 6 through 8.
- C. Maintain concrete workability without segregation of material and excessive bleeding. Obtain approval of Project Manager before adjustment and change of mix proportions.
- D. Ready-mixed concrete delivered to site shall be accompanied by batch tickets providing information required by ASTM C 94, Section 16. Concrete produced by continuous mixing shall be accompanied by batch tickets providing information required by ASTM C 685, Section 14.
- E. When adverse weather conditions affect quality of concrete, postpone concrete placement. Do not mix concrete when air temperature is at or below 40 degrees F and falling. Concrete may be mixed when temperature is 35 degrees F and rising. Take temperature readings in shade, away from artificial heat. Protect concrete from temperatures below 32 degrees F until concrete has cured for minimum of 3 days at 70 degrees F or 5 days at 50 degrees F.
- F. Clean, maintain and operate equipment so that it thoroughly mixes material as required.
- G. Hand-mix only when approved by Project Manager.

3.05 PLACING CONCRETE

- A. Give sufficient advance notice to Project Manager (at least 24 hours prior to commencement of operations) to permit inspection of forms, reinforcing steel, embedded items and other preparations for placing concrete. Place no concrete prior to Project Manager's approval.
- B. Schedule concrete placing to permit completion of finishing operations in daylight hours. However, when necessary to continue after daylight hours, light site as required. When rainfall occurs after placing operations are started, provide covering to protect work.
- C. Use troughs, pipes and chutes lined with approved metal or synthetic material in placing concrete so that concrete ingredients are not separated. Keep chutes, troughs and pipes clean and free from coatings of hardened concrete. Allow no aluminum material to be in contact with concrete.
- D. Limit free fall of concrete to 4 feet. Do not deposit large quantities of concrete at one location so that running or working concrete along forms is required. Do not jar forms after concrete has taken initial set; do not place strain on projecting reinforcement or anchor bolts.

- E. Use tremies for placing concrete in walls and similar narrow or restricted locations. Use tremies made in sections, or provide in several lengths, so that outlet may be adjusted to proper height during placing operations.
- F. Place concrete in continuous horizontal layers approximately 12 inches thick. Place each layer while layer below is still plastic.
- G. Compact each layer of concrete with concrete spading implements and mechanical vibrators of approved type and adequate number for size of placement. When immersion vibrators cannot be used, use form vibrators. Apply vibrators to concrete immediately after depositing. Move vibrator vertically through layer of concrete just placed and several inches into plastic layer below. Do not penetrate or disturb layers previously placed which have partially set. Do not use vibrators to aid lateral flow concrete. Closely supervise consolidation to ensure uniform insertion and duration of immersion.
- H. Handling and Placing Concrete: Conform to ACI 302.1R, ACI 304R and ACI 309R.

3.06 WATERSTOPS

- A. Embed waterstops in concrete across joints as shown. Waterstops shall be continuous for extent of joint; make splices necessary to provide continuity in accordance with manufacturer's instructions. Support and protect waterstops during construction operations; repair or replace waterstops damaged during construction.
- B. Install waterstops in concrete on one side of joints, leaving other side exposed until next pour. When waterstop will remain exposed for 2 days or more, shade and protect exposed waterstop from direct rays of sun during entire exposure and until exposed portion of waterstop is embedded in concrete.
- C. Splicing PVC Waterstops:
 - 1. Splice waterstops by heat-sealing adjacent waterstop sections in accordance with manufacturer's printed instructions.
 - 2. Butt end-to-end joints of two identical waterstop sections may be made in forms during placement of waterstop material.

3. Prior to placement in form work, prefabricate waterstop joints involving more than two ends to be joined together, angle cut, alignment change, or joining of two dissimilar waterstop sections, allowing not less than 24 inch long strips of waterstop material beyond joint. Upon inspection and approval by Project Manager, install prefabricated waterstop joint assemblies in form work, and butt-weld ends of 24 inch strips to straight-run portions of waterstop in forms.
- D. Setting PVC Waterstops:
1. Correctly position waterstops during installation. Support and anchor waterstops during progress of work to ensure proper embedment in concrete and to prevent folding over of waterstop by concrete placement. Locate symmetrical halves of waterstops equally between concrete pours at joints, with center axis coincident with joint openings. Thoroughly work concrete in joint vicinity for maximum density and imperviousness.
 2. Where waterstop in a vertical wall joint does not connect with any other waterstop, and is not intended to be connected to waterstop in future concrete placement, terminate waterstop 6 inches below top of wall.
- E. Replacement of Defective Field Joints: Replace waterstop field joints showing evidence of misalignment, offset, porosity, cracks, bubbles, inadequate bond or other defects with products and joints complying with Specifications.
- F. Resilient Waterstop:
1. Install resilient waterstop in accordance with manufacturer's instructions and recommendations.
 2. When requested by Project Manager, provide technical assistance by manufacturer's representative in field at no additional cost to City.
 3. Use resilient waterstop only where complete confinement by concrete is provided; do not use in expansion or contraction joints.
 4. Where resilient waterstop is used in combination with PVC waterstop, lap resilient waterstop over PVC waterstop minimum of 6 inches and place in contact with PVC waterstop. Where crossing PVC at right angles, melt PVC ribs to form smooth joining surface.
 5. At free top of walls without connecting slabs, stop resilient waterstop and grooves (where used) 6 inches from top in vertical wall joints.

6. Bentonite Waterstop:

- a. Locate bentonite waterstop as near as possible to center of joint and extend continuous around entire joint. Minimum distance from edge of waterstop to face of member: 5 inches.
- b. Where thickness of concrete member to be placed on bentonite waterstop is less than 12 inches, place waterstop in grooves at least 3/4 inch deep and 1 1/4 inches wide formed or ground into concrete. Minimum distance from edge of waterstop placed in groove to face of member: 2.5 inches.
- c. Do not place bentonite waterstop when waterstop material temperature is below 40 degrees F. Waterstop material may be warmed so that it remains above 40 degrees F during placement but means used to warm it shall in no way harm material or its properties. Do not install waterstop where air temperature falls outside manufacturer's recommended range.
- d. Place bentonite waterstop only on smooth and uniform surfaces; grind concrete smooth when necessary to produce satisfactory substrate, or bond waterstop to irregular surfaces using epoxy grout which completely fills voids and irregularities beneath waterstop material. Prior to installation, wire brush concrete surface to remove laitance and other substances that may interfere with bonding of epoxy.
- e. In addition to adhesive backing provided with waterstop, secure bentonite waterstop in place with concrete nails and washers at 12 inch maximum spacing.

7. Adhesive Waterstop:

- a. With wire brush thoroughly clean concrete surface on which waterstop is to be placed and then coat with primer.
- b. If surface is too rough to allow waterstop to form complete contact, grind to form adequately smooth surface.
- c. Install waterstop with top protective paper left in place. Overlap joints between strips minimum of 1 inch and cover back over with protective paper.
- d. Do not remove protective paper until just before final form work completion. Place concrete immediately. Time that waterstop material is uncovered prior to concrete placement shall be minimized and shall not exceed 24 hours.

3.07 CONSTRUCTION JOINTS

A. Definitions:

1. Construction joint: Contact surface between plastic (fresh) concrete and concrete that has attained initial set.
2. Monolithic: Manner of concrete placement to reduce or eliminate construction joints; joints other than those indicated on Drawings will not be permitted without written approval of Project Manager. Where so approved, make additional construction joints with details equivalent to those indicated for joints in similar locations.
3. Preparation for Construction Joints: Roughen surface of concrete previously placed, leaving some aggregate particles exposed. Remove laitance and loose materials by sandblasting or high-pressure water blasting. Keep surface wet for several hours prior to placing of plastic concrete.

3.08 CURING

- A. Comply with ACI 308. Cure by preventing loss of moisture, rapid temperature change and mechanical injury for period of 7 curing days when Type II or IP cement has been used and for 3 curing days when Type III cement has been used. Start curing as soon as free water has disappeared from concrete surface after placing and finishing. A curing day is any calendar day in which temperature is above 50 degrees F for at least 19 hours. Colder days may be counted when air temperature adjacent to concrete is maintained above 50 degrees F. In continued cold weather, when artificial heat is not provided, removal of forms and shoring may be permitted at end of calendar days equal to twice required number of curing days. However, leave soffit forms and shores in place until concrete has reached specified 28 day strength, unless directed otherwise by Project Manager.
- B. Cure formed surfaces not requiring rubbed-finished surface by leaving forms in place for full curing period. Keep wood forms wet during curing period. Add water as needed for other types of forms. Or, at Contractor's option, forms may be removed after 2 days and curing compound applied.
- C. Rubbed Finish:
 1. At formed surfaces requiring rubbed finish, remove forms as soon as practicable without damaging surface.
 2. After rubbed-finish operations are complete, continue curing formed surfaces by using either approved curing/sealing compounds or moist cotton mats until normal curing period is complete.

- D. Unformed Surfaces: Cure by membrane curing compound method.
1. After concrete has received final finish and surplus water sheen has disappeared, immediately seal surface with uniform coating of approved curing compound, applied at rate of coverage recommended by manufacturer or as directed by Project Manager. Do not apply less than 1 gallon per 180 square feet of area. Provide satisfactory means to properly control and check rate of application of compound.
 2. Thoroughly agitate compound during use and apply by means of approved mechanical power pressure sprayers equipped with atomizing nozzles. For application on small miscellaneous items, hand-powered spray equipment may be used. Prevent loss of compound between nozzle and concrete surface during spraying operations.
 3. Do not apply compound to dry surface. When concrete surface has become dry, thoroughly moisten surface immediately prior to application. At locations where coating shows discontinuities, pinholes or other defects, or when rain falls on newly coated surface before film has dried sufficiently to resist damage, apply additional coat of compound at specified rate of coverage.

3.09 REMOVAL OF FORMS AND SHORING

- A. Remove forms from surfaces requiring rubbing only as rapidly as rubbing operation progresses. Remove forms from vertical surfaces not requiring rubbed-finish when concrete has aged for required number of curing days. When curing compound is used, do not remove forms before 2 days after concrete placement.
- B. Leave soffit forms and shores in place until concrete has reached specified 28-day strength, unless directed otherwise by Project Manager.

3.10 DEFECTIVE WORK

- A. Immediately repair defective work discovered after forms have been removed. When concrete surface is bulged, uneven, or shows excess honeycombing or form marks which cannot be repaired satisfactorily through patching, remove and replace entire section.

3.11 FINISHING

- A. Patch honeycomb, minor defects and form tie holes in concrete surfaces with cement mortar mixed one part cement to two parts fine aggregate. Repair defects by cutting out unsatisfactory material and replacing with new concrete, securely keyed and bonded to existing concrete. Finish to make junctures between patches and existing concrete as inconspicuous as possible. Use stiff mixture and thoroughly tamp into place. After each patch has stiffened sufficiently to allow for greatest portion of shrinkage, strike off mortar flush with surface.

- B. Apply rubbed finish to exposed surfaces of formed concrete structures as noted on Drawings. After pointing has set sufficiently, wet surface with brush and perform first surface rubbing with No. 16 carborundum stone, or approved equal. Rub sufficiently to bring surface to paste, to remove form marks and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Spread or brush material, which has been ground to paste, uniformly over surface and allow to reset. In preparation for final acceptance, clean surfaces and perform final finish rubbing with No. 30 carborundum stone or approved equal. After rubbing, allow paste on surface to reset; then wash surface with clean water. Leave structure with clean, neat and uniform-appearing finish.
- C. Apply wood float finish to concrete slabs.

3.12 FIELD QUALITY CONTROL

- A. Testing shall be performed under provisions of Section 01454 - Testing Laboratory Services.
- B. Unless otherwise directed by Project Manager, following minimum testing of concrete is required. Testing shall be performed by qualified individuals employed by approved independent testing agency, and conform to requirements of ASTM C 1077.
 - 1. Take concrete samples in accordance with ASTM C 172.
 - 2. Make one set of four compression test specimens for each mix design at least once per day and for each 150 cubic yards or fraction thereof. Make, cure and test specimens in accordance with ASTM C 31 and ASTM C 39.
 - 3. When taking compression test specimens, test each sample for slump according to ASTM C 143, for temperature according to ASTM C 1064, for air content according to ASTM C 231, and for unit weight according to ASTM C 138.
 - 4. Inspect, sample and test concrete in accordance with ASTM C 94, Section 13, 14, and 15, and ACI 311-5R.
- C. Test Cores: Conform to ASTM C 42.
- D. Testing High Early Strength Concrete: When Type III cement is used in concrete, specified 7 day and 28 day compressive strengths shall be applicable at 3 and 7 days, respectively.
- E. If 7-day or 3-day test strengths (as applicable for type of cement being used) fail to meet established strength requirements, extended curing or resumed curing on those portions of structure represented by test specimens may be required. When additional curing fails to produce required strength, strengthening or replacement of portions of structure which fail to develop required strength may be required by Project Manager, at no additional cost to City.

3.13 PROTECTION

- A. Protect concrete against damage until final acceptance by City.
- B. Protect fresh concrete from damage due to rain, hail, sleet, or snow. Provide protection while concrete is still plastic, and whenever precipitation is imminent or occurring.
- C. Do not backfill around concrete structures or subject them to design loadings until components of structure needed to resist loading are complete and have reached specified 28 day compressive strength, except as authorized otherwise by Project Manager.

END OF SECTION

SECTION 03119**INSULATING CONCRETE FORMING****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Insulated concrete forms for:
 - a. Above grade exterior wall construction.
 - b. Interior wall construction.
 - 2. Internal bracing system.
 - 3. Installation of reinforcing steel.
 - 4. Placement of concrete within formwork.
- B. Products Installed but not Furnished Under this Section:
 - 1. Reinforcing Steel: Furnish in accordance with Section 03 20 00.
 - 2. Cast -In-Place Concrete: Furnish in accordance Section 03 30 00
 - 3. Sleeves, inserts, anchors and bolts: Furnish in accordance with Section 05 50 00 and other applicable sections.
 - 4. Bucks for Windows and Doors: Furnish in accordance with Division 08.
- C. Related Sections:
 - 1. Windows and Doors: Furnish and install in accordance with Division 08.
 - 2. Stucco, plaster, gypsum wallboard, tile and other wall finishes: Furnish and install in accordance with Division 09.
- D. This section specifies products that contribute to compliance with the following requirements of the U.S. Green Building Council (USGBC) LEED™ (Leadership in Energy & Environmental Design):
 - 1. Energy and Atmosphere Prerequisite 2 - Minimum Energy Performance.
 - 2. Energy and Atmosphere Credit 1 - Optimize Energy Performance.
 - 3. Materials and Resources Credit 2 - Construction Waste Management.
 - 4. Materials and Resources Credit 4 - Recycled Content.
 - 5. Materials and Resources Credit 5 - Regional Materials.

1.02 DEFINITIONS

- A. Insulating Concrete Form (ICF): Concrete-forming systems used for constructing cast-in-place concrete walls, consisting of stay-in-place formwork using foam-plastic insulation or other insulating materials.

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Blocks:
 - a. Modular foam stacked and interlocked to form an insulated wall system.
 - b. Field adjustable to building dimensions eliminating the need to design building to block module.
 - c. Radius designs and corners other than 90 degrees shall be possible.
 - d. Blow out resistant due to shape and chemical makeup of block.
 - e. Provide vapor retarder assembly due to air tightness of wall in final installation.
 - 2. Internal Bracing System: ThermoBlock patented system.
 - a. Braces and vertically aligns individual blocks.
 - b. Provides for rigid attachment of interior and exterior finish.
 - c. No thermal bridging.
 - d. Resists floating of blocks during placement of concrete.
 - e. Provides single point bracing of wall assembly.
 - 3. Bond Beam (poured in place): Ties vertical piers together and provides fastening point for roof / floor framing members.

- B. Performance Requirements:
 - 1. Blocks:
 - a. Average R value of 38 (8 inch thickness) per ASTM C1045.
 - b. Easily accommodates electrical and plumbing without channeling

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, design data and installation instructions. Provide 3rd party test data to support manufacturer's data.
- B. Shop Drawings: Submit drawings showing layout, dimensions and construction details.
- C. LEED™ Credit Contribution Data Sheet: In accordance with Section 01 33 00, prior to installation in the project, submit a completed data sheet, Section 00 62 33, for each of the following products which contribute to the points required for LEED™ Certification. Information contained on the Data Sheet shall be used to complete the information required for the LEED Submission.
 - 1. Blocks.
 - 2. Internal Bracing System.
 - 3. Reinforcing steel.
 - 4. Concrete.

1.05 QUALITY ASSURANCE

- A. Pre-Installation Conference:
 - 1. Convene a pre-installation conference to review specifications and procedures with the Architect, Contractor, installer, manufacturer's representative, Owner and other trades relevant to the work, prior to ordering materials.
 - 2. Verify that installer is certified by Manufacturer to install wall system.
 - 3. Notify Architect at least 48 hours prior to starting Work.
 - 4. Contractor shall review materials, details, etc. and submit a report including revised details to Architect. Incorporate revised details approved by Architect in the Project at no additional cost to Owner.
- B. Certificates: Submit notarized Contractor/Applicator certification from insulated block manufacturer as evidence of Contractor/applicator qualification and experience.

1.06 DELIVERY STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact. Protect finished surfaces with removable, recycled polyethylene wrapping which will not bond when exposed to sunlight. Packaging material used by product manufacturer shall be minimal to reduce waste. Whatever minimum material used for the packaging shall be recycled in accordance with Section 01 74 19. Packaging may be used as on-site trash collection bag.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Parent Company Manufacturing Facility: ThermoBlock, 3905 W. Van Buren Street, Suite 1, Phoenix, AZ 85009, (877) 289-4327.
- B. Manufacturing Partners: See www.thermoblock.com <<http://www.thermoblock.com>>.

2.02 MATERIALS

- A. General
 - 1. Provide recycled materials in accordance with Recycled Content provisions of Section 01 60 00.
 - a. Polyurethane insulation shall contain 9-10% recycled content from polyol produced from recycled PET bottles.

2. Provide local/regional materials in accordance with Local/Regional Materials provisions of Section 01 60 00.
- B. Blocks: 2 lb. density, cast, plural component, closed cell polyurethane foam. :
1. Size: 8 inch by 8 inch by 32 inch.
 2. Compressive Strength: 18 psi
 3. Shear Strength: 23 psi
 4. Flexural Strength: 78 psi
 5. Tensile Strength: 30 psi
 6. Vapor Permeance: 70.5 ng/Pa s.m.
 7. Foam: 2 component, rigid polyurethane.
 - a. Blowing agent: EPA-approved 245fa blowing agent meeting U.S. non-ozone-depleting requirements of the U.S. EPA mandate and International Montreal Protocol and/or reverse osmosis water based upon manufacturer recommendations. No polyurethane foam with phased-out HCFC 141b blowing agent is acceptable. Enovate® 3000 as manufactured by Honeywell is acceptable.
 - b. Polyol: Recycled content or agribase (if available).
 - c. Closed cell content: 90% minimum per ASTM D2856.
 - d. UL Class 1 flame spread.
- C. Internal Bracing System: As provided by system manufacturer.
- D. Reinforcing steel: In accordance with Section 03 20 00. Sizes shall be as indicated on drawings.
- E. Concrete: In accordance with Section 03 30 00 and as follows:
1. Compressive strength at 28 days: In accordance with General Structural Notes.
 2. Aggregate size: In accordance with insulated concrete form manufacturer's recommendation for size of void to be provided.
 3. Slump: In accordance with General Structural Notes and insulated concrete form manufacturer's recommendation for size of void to be provided.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect.
 2. Examine footings to verify that they are within acceptable tolerances for installation of wall panels.
 3. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.

3.02 INSTALLATION

- A. Installed by certified installer in accordance with manufacturer's Installation Guide.

3.03 CLEANING

- A. During the course of the Work and on completion of the Work, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.
- B. Construction Waste: In accordance with Section 01 74 19. Waste block from cuts and or damaged units shall be placed in ungrouted cells of block to provide addition thermal resistance and to minimize waste transported to landfills.

END OF SECTION

SECTION 03200**CONCRETE REINFORCEMENT****PART 1 - GENERAL****1.01 SUMMARY**

- 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 steel.

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop and installation drawings of steel reinforcement. Shop fabricator shall produce sufficient diagrams, notes, etc., to insure proper placing of reinforcing steel and submit it with each set of shop drawings for field use. Submit a placement plan and elevation for all walls.
- B. Mill Test Reports: Certified copies, evidencing compliance with the requirements of these Specifications, shall be delivered to the Architect with all deliveries of reinforcing steel.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. Reinforcing Bars: Meet requirements shown on the drawings.
- B. Welded Wire Mesh: Conform to requirements shown on the drawings.
- C. Concrete Accessories:
 - 1. Bar supports, chairs, spacers, etc., shall be cold-drawn wire and shall be fabricated in accordance with ACI Detailing Manual, SP-66, with heights as required.
 - 2. Bar supports for concrete resting on earth shall be precast concrete briquettes having tie wires embedded therein, or INDIVIDUAL HIGH CHAIRS NO. HCP with welded plates on bottom as manufactured by HOHMANN & BARNARD, INC.
- D. Threaded Reinforcing Steel Couplers:
 - 1. Lenton Threaded Standard or Transition Couplers with plastic internal coupler end protector and O-Ring, as manufactured at ERICO.
 - 2. Mechanical splice shall be capable of developing 125% of the yield point strength of the bar.

PART 3 - EXECUTION**3.01 MATERIAL STORAGE:**

- A. Reinforcing steel shall be stacked in tiers. Care shall be exercised to maintain all reinforcement free of dirt, mud, paint, rust, etc.

3.02 GENERAL:

- A. Reinforcing steel of the sizes, shapes, lengths, spacing and other dimensions shown shall be placed where shown on the Drawings. Details of reinforcing shall conform to requirements shown on the drawings.

3.03 MARKING:

- A. Plainly mark bars. Limit bundles to one size and one length.
- B. Tag each bundle with durable tags.

3.04 CLEANING:

- A. Thoroughly clean reinforcement of rust, mill scale, dirt, oil or other coatings which might tend to reduce the bonding to the concrete.

3.05 BENDING:

- A. Bend bars cold. Do not heat reinforcement.
- B. Do not handle reinforcement by makeshift methods.
- C. Do not use bars having kinks or bends not shown on the Contract Drawings.

3.06 PLACING:

- A. Accurately place and securely saddle tie reinforcement with No. 18 gage black annealed wire to prevent displacement during concrete placement.
- B. Hold reinforcement rigidly in place during the placing of the concrete by means of metal chairs or spacers.
- C. Hold bars in concrete walls in position, and to proper clearance, by means of concrete or metal spacers made especially for the locations where spacers are required.
- D. Hold bars in beams and slabs to exact location during placing of concrete by spacers, chairs, or other necessary supports.

3.07 CONCRETE COVERAGE:

- A. Provide concrete coverage for reinforcing steel as shown on the Drawings.
- B. Place reinforcement to conform to ACI 301 tolerances.

3.08 WELDING:

- A. Do not weld reinforcing steel except where specifically indicated on the drawings.
- B. For all bars indicated to be welded, provide bars which conform to ASTM A 706.
- C. Conform welding of reinforcing steel to AWS D1.4.

END OF SECTION

SECTION 04065**MORTAR AND MASONRY GROUT****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Mortar for masonry.
- B. Grout for masonry.

1.02 RELATED REQUIREMENTS

- A. Section 04812 - Thin Brick Veneer: Installation of mortar.
- B. Section 04720 - Cast Stone: Installation of mortar.
- C. Section 08110 - Steel Doors and Frames: Products and execution for grouting steel door frames installed in masonry.

1.03 REFERENCE STANDARDS

- A. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures; American Concrete Institute International; 2005.
- B. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2007.
- C. ASTM C 270 - Standard Specification for Mortar for Unit Masonry; 2007a.
- D. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout; 2007.
- E. ASTM C 476 - Standard Specification for Grout for Masonry; 2007.
- F. ASTM C 1019 - Standard Test Method for Sampling and Testing Grout; 2008.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C 270 is to be used. Also include required environmental conditions and admixture limitations.
- C. Samples: Submit two samples of mortar, illustrating mortar color and color range.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer's Instructions: Submit packaged dry mortar manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

- A. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the contract documents.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 FIELD CONDITIONS

- A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS**2.01 MATERIALS****2.02 MORTAR MIXES**

- A. Mortar for Unit Masonry: ASTM C 270, Property Specification.
 - 1. Exterior, non-loadbearing masonry: Type N.

2.03 GROUT MIXES

- A. Bond Beams and Lintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install mortar and grout to requirements of section(s) in which masonry is specified.
- B. Work grout into masonry cores and cavities to eliminate voids.

3.02 GROUTING

- A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of contract documents.

END OF SECTION

SECTION 04720**CAST STONE****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Architectural cast stone.
- B. Units required are:
 - 1. Exterior wall units, including wall caps, coping, and sills.

1.02 RELATED REQUIREMENTS

- A. Section 04065 - Mortar and Masonry Grout: Mortar for setting cast stone.
- B. Section 04810 - Unit Masonry Assemblies: Installation of cast stone in conjunction with masonry.
- C. Section 07900 - Joint Sealers: Materials and execution methods for sealing soft joints in cast stone work.

1.03 REFERENCE STANDARDS

- A. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2008.
- B. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- C. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2007.
- D. ASTM C 33 - Standard Specification for Concrete Aggregates; 2007.
- E. ASTM C 150 - Standard Specification for Portland Cement; 2007.
- F. ASTM C 270 - Standard Specification for Mortar for Unit Masonry; 2007a.
- G. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete; 2008.
- H. ASTM C 642 - Standard Test Method for Density, Absorption, and Voids in Hardened Concrete; 2006.
- I. ASTM C 1364 - Standard Specification for Architectural Cast Stone; 2007.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Mortar Color Selection Samples.
- C. Verification Samples: Pieces of actual cast stone components not less than 12 inches square, illustrating range of color and texture to be anticipated in components furnished for the project.

1.05 QUALITY ASSURANCE

- A. Mock-Up: Provide full size cast stone components for installation in mock-up of exterior wall.
 - 1. Approved mock-up will become standard for appearance and workmanship.
 - 2. Mock-up may remain as part of the completed work.
 - 3. Remove mock-up not incorporated into the work and dispose of debris.
- B. Source Quality Control: Test compressive strength and absorption of specimens selected at random from plant production.
 - 1. Test in accordance with ASTM C 642.
 - 2. Select specimens at rate of 3 per 500 cubic feet, with a minimum of 3 per production week.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cast stone components secured to shipping pallets and protected from damage and discoloration. Protect corners from damage.
- B. Number each piece individually to match shop drawings and schedule.
- C. Store cast stone components and installation materials in accordance with manufacturer's instructions.
- D. Store cast stone components on pallets with nonstaining, waterproof covers. Ventilate under covers to prevent condensation. Prevent contact with dirt.
- E. Protect cast stone components during handling and installation to prevent chipping, cracking, or other damage.
- F. Store mortar materials where contamination can be avoided.
- G. Schedule and coordinate production and delivery of cast stone components with unit masonry work to optimize on-site inventory and to avoid delaying the work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Architectural Cast Stone:
 - 1. Any current producer member of the Cast Stone Institute.

2.02 ARCHITECTURAL CAST STONE

- A. Cast Stone: Architectural concrete product manufactured to simulate appearance of natural limestone, complying with ASTM C 1364.
 - 1. Compressive Strength: As specified in ASTM C 1364; calculate strength of pieces to be field cut at 80 percent of uncut piece.
 - 2. Freeze-Thaw Resistance: Demonstrated by field experience.
 - 3. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet.
 - 4. Color: Selected by Architect from manufacturer's full range.
 - 5. Remove cement film from exposed surfaces before packaging for shipment.
- B. Shapes: Provide shapes indicated on drawings.
 - 1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch or length divided by 360, whichever is greater, but not more than 1/4 inch.
 - 2. Unless otherwise indicated on drawings, provide:
 - a. Wash or slope of 1:12 on exterior horizontal surfaces.
 - b. Drips on projecting components, wherever possible.
 - c. Raised fillets at back of sills and at ends to be built in.
- C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI 318.

2.03 MATERIALS

- A. Portland Cement: ASTM C 150.
 - 1. For Mortar: Type I or II, except Type III may be used in cold weather.
- B. Coarse Aggregate: ASTM C 33, except for gradation; granite, quartz, or limestone.
- C. Fine Aggregate: ASTM C 33, except for gradation; natural or manufactured sands.
- D. Admixtures: ASTM C 494/C 494M.
- E. Water: Potable.
- F. Reinforcing Bars: ASTM A 615/A 615M deformed bars, galvanized or epoxy coated.
- G. Steel Welded Wire Reinforcement: ASTM A 185/A 185M, galvanized or epoxy coated.

- H. Embedded Anchors, Dowels, and Inserts: Type 304 stainless steel, of type and size as required for conditions.
- I. Mortar: Portland cement-lime, as specified in Section 04065; do not use masonry cement.
- J. Sealant: As specified in Section 07900.
- K. Cleaner: General-purpose cleaner designed for removing mortar and grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; approved for intended use by cast stone manufacturer and by cleaner manufacturer for use on cast stone and adjacent masonry materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine construction to receive cast stone components. Notify Architect if construction is not acceptable.
- B. Do not begin installation until unacceptable conditions have been corrected.

3.02 INSTALLATION

- A. Install cast stone components in conjunction with masonry, complying with requirements of Section 04810.
- B. Mechanically anchor each cast stone unit.
- C. Setting:
 - 1. Drench cast stone components with clear, running water immediately before installation.
 - 2. Set units in a full bed of mortar unless otherwise indicated.
 - 3. Fill vertical joints with mortar.
 - 4. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.
- D. Joints: Make all joints 3/8 inch, except as otherwise detailed.
 - 1. Rake mortar joints 3/4 inch for pointing.
 - 2. Remove excess mortar from face of stone before pointing joints.
 - 3. Point joints with mortar in layers 3/8 inch thick and tool to a slight concave profile.
 - 4. Leave the following joints open for sealant:
 - a. Head joints in top courses, including copings, parapets, cornices, sills, and steps.
 - b. Joints in projecting units.
 - c. Joints between rigidly anchored units, including soffits, panels, and column covers.
 - d. Joints below lugged sills and stair treads.
 - e. Joints below ledge and relieving angles.
 - f. Joints labeled "expansion joint".
- E. Sealant Joints: Install sealants as specified in Section 07900.
- F. Installation Tolerances:
 - 1. Variation from Plumb: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet or more.
 - 2. Variation from Level: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet, or 3/8 inch maximum.
 - 3. Variation in Joint Width: Not more than 1/8 inch in 36 inches or 1/4 of nominal joint width, whichever is less.
 - 4. Variation in Plane Between Adjacent Surfaces (Lipping): Not more than 1/16 inch difference between planes of adjacent units or adjacent surfaces indicated to be flush with units.
- G. Repairs: Repair chips and other surface damage noticeable when viewed in direct daylight at 20 feet.
 - 1. Repair with matching touchup material provided by the manufacturer and in accordance with manufacturer's instructions.
 - 2. Repair methods and results subject to Architect 's approval.

3.03 CLEANING

- A. Clean completed exposed cast stone after mortar is thoroughly set and cured.
 - 1. Wet surfaces with water before applying cleaner.
 - 2. Apply cleaner to cast stone in accordance with manufacturer's instructions.
 - 3. Remove cleaner promptly by rinsing thoroughly with clear water.
 - 4. Do not use acidic cleaners.

3.04 PROTECTION

- A. Protect completed work from damage.
- B. Clean, repair, or restore damaged or mortar-splashed work to condition of new work.

END OF SECTION

SECTION 04810**UNIT MASONRY ASSEMBLIES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Concrete Block.
- B. Reinforcement and Anchorage.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03200 - Concrete Reinforcement: Reinforcing steel for grouted masonry.
- B. Section 04065 - Mortar and Masonry Grout.
- C. Section 04812 - Thin Brick Veneer.
- D. Section 05500 - Metal Fabrications: Loose steel lintels.
- E. Section 07620 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
- C. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

PART 2 PRODUCTS**2.01 CONCRETE MASONRY UNITS**

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depth of 8 inches.

2.02 REINFORCEMENT AND ANCHORAGE

- A. Reinforcing Steel: ASTM A 615/A 615M Grade 40 (280) deformed billet bars; ____.
- B. Single Wythe Joint Reinforcement: Truss type; ASTM A 82/A 82M steel wire, mill galvanized to ASTM A 641/A 641M, Class 3; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

2.03 ACCESSORIES**PART 3 EXECUTION****3.01 EXAMINATION**

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COLD AND HOT WEATHER REQUIREMENTS

- A. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

3.04 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:
 - 1. Bond: Running.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches.
 - 3. Mortar Joints: Flush.

3.05 PLACING AND BONDING

- A. Lay hollow masonry units with face shell bedding on head and bed joints.
- B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- C. Remove excess mortar and mortar smears as work progresses.
- D. Interlock intersections and external corners.
- E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- F. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.06 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

END OF SECTION

SECTION 04812**THIN BRICK****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Thin Brick Veneer

1.02 RELATED SECTIONS

- A. Section 04065 - Mortar and Masonry Grout.

1.03 REFERENCES

- A. ASTM C 67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
- B. ASTM C 1088 - Standard Specification for Thin Veneer Brick Units Made From Clay or Shale.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures
- B. Endicott Clay Products Company, thin brick units: Manufacturer's catalog data, detail sheets, and printed installation instructions.
- C. Selection Samples: For each product requiring color/texture selection, provide full size samples for final selection.

1.05 SAMPLE PANELS

- A. Construct sample panel at location indicated or directed, and as follows:
 - 1. Size: 4 feet by 4 feet (1.2 m by 1.2 m).
 - 2. Include all unit types and sizes to be used, and mortar joint treatment.
- B. Obtain architect's acceptance of sample panel before beginning construction activities of this section.
- C. Do not remove sample panel until construction activities of this section have been accepted by architect.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products of this section on pallets, with individual faces protected; keep dry.
- B. Store units in protected area or under cover on level ground; keep dry. Do not double-stack pallets.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Acceptable Manufacturer: Endicott Clay Products Co., which is located at: 57120 707th Rd. ; Endicott, NE 68350; Tel: 402-729-3315; Fax: 402-729-5804; www.endicott.com
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600.
- C. Provide all thin brick from a single manufacturer.

2.02 MATERIALS

- A. Thin Brick: ASTM C 1088, Type TBX, tested in accordance with ASTM C 67.
 - 1. Size: 3-5/8 inches (92.1 mm) high, 7-5/8 inches (193.7 mm) long, 1/2 inch (12.7 mm) thick.
 - 2. Texture: Wirecut.
 - 3. Color: As selected by Architect from manufacturer's standard range.
- B. Trim Units: Matching thin brick.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect related conditions; do not start work in an area until adverse conditions in that area are corrected.

3.02 PREPARATION

- A. Test surfaces for straightness, levelness. Notify architect where corrections are needed.

3.03 INSTALLATION

- A. Install thin brick in accordance with manufacturer's printed instructions.
- B. Cut units where required for fitting or for installation of built-in items, using power tools; do not install units having chipped or cracked edges on sight-exposed surfaces.
- C. Align base courses to follow accurate floor lines.
- D. Align faces plumb, level, and true, with uniform joint widths.
- E. Size and portion units for best appearance, with joints arranged neat and symmetrical, free of imperfections detracting from overall appearance.

3.04 FIELD QUALITY CONTROL

- A. Architect will observe appearance of installed units; installed masonry surfaces shall be free of imperfections which detract from overall appearance when viewed from a distance of 5 feet (1.5 m) at 90 degrees normal to surface.

3.05 CLEANING

- A. Clean installed masonry surfaces in accordance with manufacturer's instructions; do not clean units with products not specified in manufacturer's instructions.

END OF SECTION

SECTION 05120**STRUCTURAL STEEL****PART 1 - GENERAL****1.01 RELATED WORK SPECIFIED ELSEWHERE:**

- A. TESTING: Section 01800
- B. CAST-IN-PLACE CONCRETE: Section 03300
- C. STEEL JOISTS AND JOIST GIRDERS: Section 05211
- D. STEEL DECK: Section 05300
- E. MISCELLANEOUS METAL: Section 05500

1.02 DESCRIPTION OF WORK:

- A. Extent of structural steel work is shown on drawings, including schedules, notes and details to show size and location of members, typical connections and type of steel required.
- B. Structural steel is that work defined in AISC "Code of Standard Practice" and as otherwise shown on drawings.

1.03 QUALITY ASSURANCE:

- A. Codes and Standards: Comply with provisions of following except as otherwise indicated:
 - 1. AISC "Code of Standard Practice for Steel Buildings and Bridges".
 - 2. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including the "Commentary" and Supplements thereto issued.
 - 3. AISC "Specifications for Structural Joints using ASTM A0325 or A-490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
 - 4. AWS D1.1 "Structural Welding Code".
 - 5. ASTM A-6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
- B. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".
 - 1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests within previous 12 months.
 - 2. If recertification of welders is required, retesting will be Contractor's responsibility.
- C. Testing of Welds: The Owner may require non-destructive weld tests performed by a testing laboratory, of any welded assembly at any time. This requirement supercedes AWS 6.6.4, 6.6.5, and 6.7.1.
 - 1. The Contractor shall be responsible for all associated costs where defective welds are disclosed, including handling, surface preparation, non-destructive testing and retesting of unacceptable welds and repair of defects.
 - 2. Fabricator shall inform testing laboratory of the fabrication schedule of items that require testing and supervision with sufficient time to avoid delay in the work.

1.04 SUBMITTALS:

- A. Product Data: Submit producer's or manufacturer's specifications and 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 mill reports covering chemical and physical properties.
 - 2. High-strength bolts (each type), including nuts and washers.
 - 3. Structural steel primer paint.

4. Shrinkage-resistant grout.
- B. Shop Drawings: Submit shop drawings prepared under supervision of a registered professional engineer, including complete details, schedules and diagrams for fabrication and assembly of structural steel members.
 1. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.
 2. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.
 3. Reproduction of structural construction documents for shop drawing submittals will not be allowed.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time not to delay that work.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- C. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Structural Steel Wide-Flange Shapes: ASTM A-992, $F_y = 50$ ksi.
- B. Miscellaneous Structural Steel Shapes, Plates and Bars: ASTM A-36, except where other type steel is indicated.
- C. Structural Steel Tubing: ASTM A-500, Grade B, $F_y = 46$ ksi.
 1. Finish: Black except where indicated to be galvanized.
- D. Welded and Seamless Steel Pipe: ASTM A-53, Grade B.
- E. Anchor Bolts: ASTM F1554 headed type unless otherwise indicated. Provide either hexagonal or square heads and nuts, except use only hexagonal units for exposed connections.
- F. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:
 1. Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A-325.
- G. Electrodes for Welding: Comply with AWS Code. For high-strength, low-alloy steel, provide electrodes, welding rods and filler metals equal in strength and compatible in appearance with parent metal joined.
- H. Structural Steel Primer Paint: Fabricator's standard rust-inhibiting primer. Complying with SSPC-Paint 13 or FS TT-P-636.
- I. Non-Metallic Shrinkage-Resistant Grout: Premixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with CRD-C588, Type A, 7,500 psi minimum compressive strength.
 1. Products: Provide non-metallic, non-shrink grout as manufactured by one of the following:
 - a. Euco N.S.; Euclid Chemical Company
 - b. Crystex; L&M Construction Chemicals
 - c. Masterflor 713; Master Builders
 - d. Supreme Grout; Gifford-Hill
 - e. Five Star Grout; U.S. Grout Corporation
 - f. Upcon; Upco Chemical Division, USM Corporation

- g. Propak; Protex Industries, Inc.

2.02 FABRICATION:

- A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.
1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
 2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other effects.
- B. Connections: Weld or bolt shop connections as indicated.
1. Bolt field connections, except where welded connections or other connections are indicated.
 - a. Provide high-strength threaded fasteners for principal bolted connections.
 - b. Provide unfinished threaded fasteners for only bolted connections of secondary framing to primary members (including purlins, girts, and other framing members taking only nominal stresses) and temporary bracing to facilitate erection.
 2. High-strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A-325".
- C. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.
- D. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on approved shop drawings.
1. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.
 2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes by burning. Drill holes in bearing plates.
- E. Provide continuous steel angle support for metal deck canopies at building wall. Continuous angle to be welded to clip angle supports embedded in masonry. Expansion bolts, grouted anchor bolts, etc. are not permitted.

2.03 SHOP PAINTING:

- A. General: Shop paint structural steel, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel which is partially exposed on exposed portions and initial 2" of embedded areas only. DO NOT PAINT SURFACES WHICH ARE TO BE WELDED. All structural steel that is exposed to weather shall be galvanized. Any damage to galvanic material during field welding shall be repaired with tenemic paint.
- B. Surface Preparation: After inspection and before shipping, clean steel work to be painted. Remove loose rust, loose mill scale, and spatter, slag or flux deposits.
- C. Painting: Provide a one-coat shop applied paint system complying with Steel Structures Painting Council (SSPC) - paint System 7.01.
1. Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide a uniform dry film thickness of 1.5 mils.
 2. Use painting methods which result in full coverage of joints, corners, edges and exposed surfaces.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Erector must examine areas and conditions under which structural steel work is to be installed, and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Erector.

3.02 ERECTION:

- A. Surveys: Employ a registered professional engineer or land surveyor, experienced in survey work, to establish permanent benchmarks as shown and as necessary for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Architect. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Architect.
- B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.
- C. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.
- D. Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place work.
 - 1. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.
 - 2. Refer to Division 3 of these specifications for anchor bolt installation requirements in concrete, and Division 4 for masonry installation.
- E. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
 - 1. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.
- F. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
- G. Pack grout solidly between bearing surfaces and bases of plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allowed to cure.
- H. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure within specified AISC tolerances.
 - 2. Splice members only where indicated on structural drawings.
 - 3. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 4. Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary members. Ream holes that must be enlarged to admit bolts.
- I. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in structural framing. Cutting will be permitted only on secondary members which are not under stress, as acceptable to Architect. Finish gas-cut sections equal to a sheared appearance when permitted.
- J. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to areas with same material as used for shop painting.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

3.03 QUALITY CONTROL:

- A. The Owner may engage an independent testing and inspection agency to inspect high-strength bolted connections and to perform tests and prepare test reports.
 - 1. Testing agency shall conduct and interpret tests and state in each report whether test specimens comply with requirements and specifically state any deviations therefrom.

2. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.
 3. Testing agency may inspect structural steel at plant before shipment; however, Architect reserves the right, at any time before final acceptance, to reject material not complying with specified requirements.
- B. Correct deficiencies in structural steel work which inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any noncompliance of original work, and as may be necessary to show compliance of corrected work.

END OF SECTION

SECTION 05211**STEEL JOIST & JOIST GIRDERS****PART 1 - GENERAL****1.01 RELATED WORK SPECIFIED ELSEWHERE:**

- A. CAST-IN-PLACE CONCRETE: Section 03300.
- B. STRUCTURAL STEEL: Section 05120.
- C. STEEL DECK: Section 05300.

1.02 DESCRIPTION OF WORK:

- A. Extent of steel joists and joist girders is shown on drawings, including basic layout and type of joists required.

1.03 QUALITY ASSURANCE:

- A. Provide joists fabricated in compliance with the SJI "Standard Specifications, Load Tables and Weight Tables" for Open Web Steel Joists and as herein specified.
- B. Qualifications of Welding: Quality welding processes and welding operators in accordance with the AWS "Standard Qualification Procedure".
 - 1. Provide certification that welders to be employed in work have satisfactorily passes AWS qualification tests within previous 12 months.
 - 2. If recertification of welders is required, retesting will be Contractor's responsibility.
 - 3. Joists welded in place are subject to inspection and testing. Expense of removing and replacing any portion of steel joists for testing purposes will be borne by Owner if welds are found to be satisfactory. Remove and replace work found to be defective and provide new acceptable work.
 - 4. All welding for erection to be in accordance with AWS D1.1.

1.04 SUBMITTALS:

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of joist and accessories. Include manufacturer's certification that joists and joist girders comply with SJI "Specifications".
- B. Shop Drawings: Submit detailed drawings showing layout of joist units, special connections, jointing and accessories. Include make, number, type, location and spacing of joists and bridging.
 - 1. Provide templates or location drawings for installation of anchor bolts.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Deliver, store and handle steel joists as recommended in SJI "Specifications". Handle and store joists in a manner to avoid deforming members and to avoid excessive stresses.

PART 2 - PRODUCTS**2.01 MATERIALS:**

- A. Steel: Comply with SJI "Specifications". Comply with AISC "Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings".
- B. Structural Steel Tubing: ASTM A-500, Grade B, or approved equal.
- C. Steel Prime Paint: Provide primer complying with FS TT-P-636.

2.02 FABRICATION:

- A. General: Fabricate steel joists in accordance with SJI "Specifications".

- B. Bridging: Provide horizontal or diagonal type bridging for "open web" joists, complying with SJI "Specifications", unless shown otherwise.
 - 1. Provide bridging anchors for ends of bridging lines terminating at walls or beams.
- C. End Anchorage: Provide end anchorages to secure joists to adjacent construction, complying with SJI "Specifications", unless otherwise indicated.
- D. Header Units: Provide header units to support tail joists at openings in floor or roof system not framed with steel shapes.
- E. Shop Painting: Remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories before application of shop paint.
 - 1. Apply one shop coat of primer paint to steel joists and accessories, by spray, dipping, or other method to provide a continuous dry paint film thickness of not less than 1.50 mil.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Erector must examine areas and conditions under which steel joists are to be installed, and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Erector.

3.02 ERECTION:

- A. Place and secure steel joists in accordance with SJI "Specifications", final shop drawings, and as herein specified.
- B. Placing Joists: Do not start placement of steel joists until supporting work is in place and secured. Place joists on supporting work, adjust and align in accurate locations and spacing before permanently fastening.
 - 1. Provide temporary bridging, connections and anchors to ensure lateral stability during construction.
 - 2. Bridging: Install bridging simultaneously with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams.
- C. Fastening Joists and Joist Girders:
 - 1. Field weld joists to supporting steel framework in accordance with SJI "Specifications" for type of joists used and in accordance with AWS D1.1. Coordinate welding sequence and procedure with placing of joists.
 - 2. Bolt joist girders to supporting steel framework with A-325 bolts, unless shown otherwise.
- D. Touch-Up Painting: After joist installation, paint field bolt heads and nuts, and welded areas, abraded or rusty surfaces on joists and steel supporting members. Wire brush surfaces and clean with solvent before painting. Use same type of paint as used for shop painting.
- E. Do not suspend any equipment, piping, ducting, etc. from joist bridging or bottom chords of joists. Provide additional angle framing members, or appropriate Unistrut supports, for this purpose if required. Support these elements from the top chords of joists only.

END OF SECTION

SECTION 05300**STEEL DECK****PART 1 - GENERAL****1.01 RELATED WORK SPECIFIED ELSEWHERE:**

- A. STRUCTURAL STEEL: Section 05120
- B. STEEL JOISTS AND JOIST GIRDERS: Section 05211

1.02 QUALITY CONTROL:

- A. Material: Manufacturer must be a member of the Steel Deck Institute.
- B. Fabrication: Qualify welding processes and operators in accordance with AWS "Standard Qualification Procedure". Operators shall carry proof of qualification on their person.
- C. Standards:
 - 1. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings (with commentary)", dated June 1, 1989.
 - 2. AWS "Structural Welding Code".
 - 3. SDI "Design Manual for Floor and Roof Decks".
- D. Protection: Protect decking panels from moisture or mechanical damage.

1.03 SUBMITTALS:

- A. Submit shop drawings showing complete details and instructions for fabrication, assembly and installation.

PART 2 - PRODUCTS**2.01 STEEL DECKING:**

- A. Roof: SDI Deck, grade as shown on structural drawings with manufacturer's standard baked-on paint coating.

2.02 GALVANIZING:

- A. ASTM A-525, G60, 1.25 oz.

2.03 PAINT:

- A. Use deck manufacturer's standard factory applied primer, one coat.

2.04 APPROVED MANUFACTURERS:

- A. U.S. Steel Corporation
- B. Vulcraft
- C. Wheeling Corrugating Company

PART 3 - EXECUTION**3.01 GENERAL:**

- A. Form deck units in lengths to span 3 or more supports, with flush, telescoped or nested 2" laps at ends and interlocking or nested side laps.

3.02 INSPECTION:

- A. Installer must examine areas and conditions under which metal decking is to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.03 INSTALLATION:

- A. General: Install deck units and accessories in accordance with manufacturer's recommendations and final shop drawings, and as specified herein.
 - 1. Place deck units on supporting steel framework and adjust to final position with ends accurately aligned and bearing on supporting members before being permanently fastened. Do not stretch or contract side lap interlocks.
 - 2. Place deck units flat and square, secure to adjacent framing without warp or excessive deflection.
 - 3. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
- B. Fastening Deck Units:
 - 1. Fasten roof deck units to steel supporting members by not less than 5/8" diameter fusion welds or elongated welds of equal strength, spaced not more than 12" on center at supports, and closer spacing where required for lateral force resistance, or as indicated on the drawings.
 - 2. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work. Use welding washers where recommended by deck manufacturer.
 - 3. Fasten deck mechanically with screws on side laps as noted on drawings. Verify installation procedure with Roofing Inspection Company.
- C. Cutting and Fitting: Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking, as shown.
- D. Provide all required edge reinforcing channels or angles, closures, plates and other accessories which must be attached directly to the steel deck in order to provide a finished surface for the application of insulation and roofing.
- E. Reinforcement at openings: Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking and support of other work shown. Provide L4x4x1/4 steel angle reinforcement adjacent to all openings greater than 12" diameter unless otherwise detailed.
- F. Touch-Up Painting: After decking installation, wire brush, clean and paint scarred areas, welds and rust spots on exposed surfaces of decking units and supporting steel members. Touch-up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions. Touch-up painted surfaces with same type of shop paint used on adjacent surfaces.
- G. Suspension of any mechanical or electrical equipment, such as ducts, piping, light fixtures, etc., from main roof deck will not be permitted.

END OF SECTION

SECTION 05400**COLD FORMED METAL FRAMING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Formed steel stud exterior wall and interior wall framing.
- B. Exterior wall sheathing.
- C. Water-resistive barrier over sheathing.

1.02 RELATED REQUIREMENTS

- A. Section 07212 - Board and Batt Insulation: Insulation within framing members.
- B. Section 07900 - Joint Sealers.
- C. Section 09220 - Portland Cement Plaster.

1.03 REFERENCE STANDARDS

- A. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)
- B. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.
- C. ASTM C 955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases; 2007.
- D. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2006.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other sections that is to be installed in or adjacent to the metal framing system, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, limitations.
- C. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Metal Framing, Connectors, and Accessories:
 - 1. Dietrich Metal Framing: www.dietrichindustries.com.
 - 2. MarinoWare: www.marinoware.com.
 - 3. The Steel Network, Inc: www.SteelNetwork.com.
 - 4. Substitutions: See Section 01600 - Product Requirements.

2.02 FRAMING SYSTEM

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

2.03 FRAMING MATERIALS

- A. Studs and Track: ASTM C 955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
 - 1. Gage and depth: As indicated on the drawings.
- B. Framing Connectors: Factory-made formed steel sheet, ASTM A 653/A 653M SS Grade 50, with G60/Z180 hot dipped galvanized coating and factory punched holes.
 - 1. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold Formed Steel Structural Members; minimum 16 gage, 0.06 inch thickness.
 - 2. Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.

2.04 WALL SHEATHING

- A. Wall Sheathing, Securock: Glass mat faced gypsum; ASTM C 1177/C 1177M, square long edges, 5/8 inch Type X fire-resistant.

2.05 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
- B. Water-Resistive Barrier: 60 minute water-resistive Kraft building paper.

2.06 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A 153/A 153M.
- B. Anchorage Devices: Power actuated.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.02 INSTALLATION OF STUDS

- A. Install components in accordance with manufacturers' instructions and ASTM C 1007 requirements.
- B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches on center. Coordinate installation of sealant with floor and ceiling tracks.
- C. Place studs at 12 inches on center; not more than 2 inches from abutting walls and at each side of openings. Connect studs to tracks using clip and tie method.
- D. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- E. Install load bearing studs full length in one piece. Splicing of studs is not permitted.
- F. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- G. Install intermediate studs above and below openings to align with wall stud spacing.

- H. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.
- I. Attach cross studs to studs for attachment of fixtures anchored to walls.
- J. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.

3.03 WALL SHEATHING

- A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
 - 1. Place water-resistive barrier horizontally over wall sheathing, weather lapping edges and ends.

END OF SECTION

SECTION 05510**METAL STAIRS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Stairs with concrete treads.
- B. Structural steel stair framing and supports.
- C. Handrails and guards.

1.02 RELATED REQUIREMENTS

- A. Section 03300 - Cast-in-Place Concrete: Concrete fill in stair pans and landings; mesh reinforcement for landings.
- B. Section 03300 - Cast-in-Place Concrete: Placement of metal anchors in concrete.
- C. Section 04810 - Unit Masonry Assemblies: Placement of metal fabrications in masonry.

1.03 REFERENCE STANDARDS

- A. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2005.
- B. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.
- C. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.
- D. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2007a.
- E. ASTM A 325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2007.
- F. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2007.
- G. ASTM A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2007.
- H. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2007.
- I. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2006 and Errata.
- J. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).
- K. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Include the design engineer's stamp or seal on each sheet of shop drawings.
- C. Welders' Certificates.

1.05 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.
- B. Welder Qualifications: Show certification of welders employed on the Work, verifying AWS qualification within the previous 12 months.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 - 1. Regulatory Requirements: Provide stairs and railings complying with the most stringent requirements of local, state, and federal regulations; where requirements of the contract documents exceed those of regulations, comply with the contract documents.
 - 2. Structural Design: Provide complete stair and railing assemblies complying with the applicable local code.
 - 3. Dimensions: As indicated on drawings.
 - 4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 - 5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 - 6. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
 - 1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
 - a. Welded Joints: Continuously welded and ground smooth and flush.
 - b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
 - c. Exposed Edges and Corners: Eased to small uniform radius.
 - d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH CONCRETE TREADS

- A. Jointing and Finish Quality Level: Architectural, as defined above.
- B. Risers: Closed.
- C. Treads: Metal pan with field-installed concrete fill.
 - 1. Concrete Depth: 1-1/2 inches, minimum.
 - 2. Tread Pan Material: Steel sheet.
 - 3. Tread Pan Thickness: As required by design; 14 gage, 0.075 inch minimum.
 - 4. Concrete Reinforcement: None.
 - 5. Concrete Finish: For resilient floor covering.
- D. Risers: Same material and thickness as tread pans.
 - 1. Nosing Depth: Not more than 1-1/2 inch overhang.
 - 2. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch wide.
- E. Stringers: Rolled steel channels.
 - 1. Stringer Depth: 10 inches.
 - 2. End Closure: Sheet steel of same thickness as risers welded across ends.
- F. Railings: Steel pipe railings.

- G. Finish: Shop- or factory-prime painted.
- H. Under Side of Stair: Exposed to view, to be finished same as specified for other exposed to view surfaces.

2.03 HANDRAILS AND GUARDS

- A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
 - 1. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
- B. Guards:
 - 1. Top Rails: Round pipe or tube rails unless otherwise indicated.
 - a. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
 - 2. Infill at Picket Railings: Vertical pickets.
 - a. Horizontal Spacing: Maximum 4 inches on center.
 - b. Material: Solid steel bar.
 - c. Shape: Square.
 - d. Size: 1/4 inch square.
 - e. Top Mounting: Welded to underside of top rail.
 - f. Bottom Mounting: Welded to top surface of stringer.
 - 3. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.
 - a. Outside Diameter: 1 inch.
 - b. Material: Steel pipe or tube, round.
 - c. Vertical Spacing: Maximum 4 inches on center.
 - d. Jointing: Welded and ground smooth and flush.
 - 4. Infill at Mesh Railings: Woven wire mesh panels.
 - a. Material and Finish: Same as stair.
 - b. Mounting: Mesh welded to steel bar frame, frame welded to posts.
 - 5. End and Intermediate Posts: Same material and size as top rails.
 - a. Horizontal Spacing: As indicated on drawings.
 - b. Mounting: Welded to top surface of stringer.

2.04 MATERIALS

- A. Steel Sections: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A 500 or ASTM A 501 structural tubing, round and shapes as indicated.
- C. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.
- D. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
 - 1. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Designation CS (commercial steel).
 - 2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Designation CS (commercial steel).
- E. Concrete Fill: Type specified in Section 03300.
- F. Steel Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components.
- G. Welding Materials: AWS D1.1; type required for materials being welded.
- H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.05 SHOP FINISHING

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Prime Painting: Use specified shop- and touch-up primer.
 - 1. Preparation of Steel: In accordance with SSPC-SP 2, Hand Tool Cleaning.

2. Number of Coats: One.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. When field welding is required, clean and strip primed steel items to bare metal.
- B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

3.03 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1.
- E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
- F. Obtain approval prior to site cutting or creating adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION

SECTION 05730**ORNAMENTAL FORMED METAL****PART 2 PRODUCTS****1.01 FORMED METAL FABRICATIONS**

- A. General: Assemble metal panels, fasteners, and anchors in configurations and dimensions shown on the drawings.
 - 1. Provide panel jointing using reveal joints and gaskets but no sealant.
 - 2. Anchor panels to supporting framing without exposed fasteners.
- B. Panels: One inch deep pans formed of metal composite material sheet by routing back edges of sheet, removing corners, and folding edges.
 - 1. Reinforce corners with riveted aluminum angles.
 - 2. Provide concealed attachment to supporting structure by adhering attachment members to back of panel; attachment members may also function as stiffeners.
 - 3. Maintain maximum panel bow of 0.8 percent of panel dimension in width and length; provide stiffeners of sufficient size and strength to maintain panel flatness without showing local stresses or read-through on panel face.
 - 4. Secure members to back face of panels using structural silicone sealant approved by MCM sheet manufacturer.
 - 5. Fabricate panels under controlled shop conditions.
 - 6. Where final dimensions cannot be established by field measurement before commencement of manufacturing, make allowance for field adjustments without requiring field fabrication of panels.
 - 7. Fabricate as indicated on drawings and as recommended by MCM sheet manufacturer.
 - a. Make panel lines, breaks, curves and angles sharp and true.
 - b. Keep plane surfaces free from warp or buckle.
 - c. Keep panel surfaces free of scratches or marks caused during fabrication.

1.02 MATERIALS

- A. Metal Composite Material (MCM) Sheet: Two sheets of aluminum sandwiching a solid core of extruded thermoplastic material formed in a continuous process with no glues or adhesives between dissimilar materials; core material free of voids and spaces; no foamed insulation material content.
 - 1. Overall Sheet Thickness: 4 mm.
 - 2. Face Sheet Thickness: 0.19 inches, minimum.
 - 3. Alloy: Manufacturer's standard, selected for best appearance and finish durability.
 - 4. Bond and Peel Strength: No adhesive failure of the bond between the core and the skin nor cohesive failure of the core itself below 22.4 inch-pound/inch with no degradation in bond performance, when tested in accordance with ASTM D 1781, simulating resistance to panel delamination, after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F.
 - 5. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E 84.
 - 6. Flammability: Self-ignition temperature of 650 degrees F or greater, when tested in accordance with ASTM D 1929.
- B. Metal Framing Members: Include all sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
 - 1. Provide material strength, dimensions, configuration as required to meet the applied loads applied and in compliance with applicable building code.
 - 2. Sheet Steel Components: ASTM A 653/A 653M galvanized to G90/Z275 or zinc-iron alloy-coated to A60; or ASTM A 792/A 792M aluminum-zinc coated to AZ60.
 - 3. Stainless Steel Sheet Components: ASTM A 480/A 480M.
- C. Anchors, Clips and Accessories: Use one of the following:
 - 1. Stainless steel complying with ASTM A 480/A480M, ASTM A 276 or ASTM A 666.

2. Steel complying with ASTM A 36/A 36M and hot-dipped galvanized to ASTM A153/A153M.
 3. Steel complying with ASTM A 36/A 36M and hot-dipped galvanized to ASTM A123/A123M Coating Grade 10.
- D. Fasteners:
1. Exposed fasteners: Stainless steel; permitted only where absolutely unavoidable and subject to prior approval of the Architect.
 2. Screws: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
 3. Bolts: Stainless steel.
- E. Provide fabricator's standard corrosion resistant accessories, including fasteners, clips, anchorage devices and attachments.

END OF SECTION

SECTION 06200**FINISH CARPENTRY****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Finish carpentry items.
- B. Wood door frames, glazed frames.
- C. Wood casings and moldings.
- D. Hardware and attachment accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 09900 - Paints and Coatings: Painting and finishing of finish carpentry items.
- C. Section 12355 - Residential Casework: Shop fabricated cabinet work.

1.03 REFERENCE STANDARDS

- A. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2008.
- B. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2003 (ANSI/BHMA A156.9).
- C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; Hardwood Plywood & Veneer Association; 2004.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.
- B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide instructions for attachment hardware and finish hardware.
- C. Samples: Submit two samples of finish plywood, 6x6 inch in size illustrating wood grain and specified finish.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect work from moisture damage.

PART 2 PRODUCTS**2.01 MATERIALS - GENERAL**

- A. Unless otherwise indicated provide products of quality specified by AWI Architectural Woodwork Quality Standards Illustrated for Premium grade.
- B. Unless otherwise indicated provide products of quality specified by Woodwork Institute Manual of Millwork for Premium grade.

2.02 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

- B. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless otherwise noted, provided it is clean and free of contamination; identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc.

2.03 ADHESIVE

- A. Adhesive: Type recommended by laminate manufacturer to suit application.

2.04 HARDWARE

- A. Hardware: Comply with BHMA A156.9.

2.05 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

- A. Set and secure materials and components in place, plumb and level.
- B. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.

3.03 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush apply one coats of preservative treatment on wood in contact with cementitious materials. Treat site-sawn cuts.
- C. Allow preservative to dry prior to erecting members.

3.04 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.

3.05 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

END OF SECTION

SECTION 06415**COUNTERTOPS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Countertops for architectural cabinetwork.
- B. Countertops for manufactured casework.
- C. Wall-hung counters and vanity tops.
- D. Epoxy resin sinks.

1.02 RELATED REQUIREMENTS

- A. Section 06410 - Custom Cabinets.
- B. Section 11600 - Laboratory Equipment: Work surfaces inside fume hoods.
- C. Section 12355 - Residential Casework.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01210 - Allowances, for cash allowances affecting this section.

1.04 REFERENCE STANDARDS

- A. ANSI Z124.3 - American National Standard for Plastic Lavatories; 2005.
- B. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.
- C. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2006.
- D. AWI/AWMAC (QSI) - Quality Standard Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2005, 8th Ed., Version 2.0.
- E. ISSFA-2 - Classification and Standards for Solid Surfacing Material; International Solid Surface Fabricators Association; 2001 (2002)
- F. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
- D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
- E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOP ASSEMBLIES

- A. Plastic Laminate Countertops: High pressure decorative laminate sheet bonded to substrate.
 - 1. Laminate Sheet, Unless Otherwise Indicated: NEMA LD 3 Grade HGS, 0.048 inch nominal thickness.
 - a. Finish: Matte or suede, gloss rating of 5 to 20.
 - b. Surface Color and Pattern: To be selected from manufacturer's full line.
 - 2. Back and End Splashes: Same material, same construction.
- B. Chemical Resistant Plastic Laminate Countertops: Chemical resistant high pressure decorative laminate sheet bonded to substrate.
 - 1. Laminate Sheet: NEMA LD 3 Grade HGL, 0.039 inch nominal thickness.
 - a. Chemical Resistance: In addition to the requirements of NEMA LD 3, provide products that resist the following chemicals with not more than Moderate Effect when tested in the same manner as specified in NEMA LD 3:
 - b. Finish: Matte or suede, gloss rating of 5 to 20.
 - c. Surface Color and Pattern: To be selected from manufacturer's full line.
 - 2. Back and End Splashes: Same material, same construction; minimum 4 inches high.
- C. Epoxy Resin Countertops: Filled epoxy resin molded into homogenous, non-porous sheets; no surface coating and color and pattern consistent throughout thickness; with integral or adhesively seamed components.
 - 1. Flat Surface Thickness: 1 inch, nominal.
 - 2. Flammability: Self-extinguishing, when tested in accordance with ASTM D 635.
 - 3. Surface Finish: Smooth, non-glare.
 - 4. Color: Black.
 - 5. Back and End Splashes: Same material, same thickness; separate for field attachment.
 - 6. Sinks: Same material, same color; integrally molded with counter; bottom sloped to outlet; molded outlets; drain outlet located in back corner.
 - a. Sides and Ends: 1/2 inch minimum thickness.
 - b. Bottoms: 5/8 inch minimum thickness.
 - c. Interior Corners: 1 inch minimum radius.
 - d. Clamping collars for 1-1/2 or 2 inch diameter waste pipe, for sealed but not permanent connection.
 - e. Steel channel supports front to back on each side, fastened to underside of top to support twice full sink weight.
- D. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 1/4 inch, minimum.
 - 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISSFA-2 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Sinks and Bowls: Integral castings; minimum 3/4 inch wall thickness; comply with ANSI Z124.3.
 - b. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - c. Color and Pattern: To be selected from manufacturer's full line.

3. Other Components Thickness: 1/2 inch, minimum.
 4. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
- E. Stainless Steel Countertops: ASTM A 666 Type 304 stainless steel sheet; 16 gage, 0.06 inch nominal sheet thickness.
1. Finish: 4B satin brushed finish.
 2. Sinks: Same material, same thickness; flush welded to counter; bottom sloped to outlet; radiused interior corners; drain outlet located in back corner.

2.02 ACCESSORY MATERIALS

- A. Wood-Based Components:
1. Wood fabricated from old growth timber is not permitted.
- B. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- C. Cove Molding for Top of Splashes: Rubber with semi-gloss finish and T-spline to fit between splash and wall; 1/2 inch by 1/2 inch; color as selected.
- D. Joint Sealant: Mildew-resistant silicone sealant, white.

2.03 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
- D. Stainless Steel: Fabricate tops up to 144 inches long in one piece including nosings and back and end splashes; accurately fitted mechanical field joints in lengths over that dimension are permitted.
1. Weld joints; grind smooth and polish to match.
 2. Provide stainless steel hat channel stiffeners, welded or soldered to underside, where indicated on drawings.
 3. Provide wall clips for support of back/end splash turndowns.
 4. Sound Deadening: Apply water resistant, fire resistant sound deadening mastic to entire bottom surface.
- E. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- C. Attach stainless steel countertops using stainless steel fasteners and clips.
- D. Attach epoxy resin countertops using compatible adhesive.
- E. Seal joint between back/end splashes and vertical surfaces.
 - 1. Where indicated use rubber cove molding.
 - 2. Where applied cove molding is not indicated use specified sealant.

3.04 CLEANING

- A. Clean countertops surfaces thoroughly.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07115**BITUMINOUS DAMPPROOFING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Bituminous dampproofing.
- B. Protection boards.
- C. Drainage panels.

1.02 RELATED REQUIREMENTS

- A. Section 07212 - Board and Batt Insulation: Rigid insulation board used as protection board.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide properties of primer, bitumen, and mastics. Also provide product's test data.
- C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with NRCA Roofing and Waterproofing Manual.
- B. Installer Qualifications: Company specializing in performing the work of this section approved by manufacturer.

1.05 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Other Acceptable Manufacturers:
 - 1. Karnak Chemical Corp: www.karnakcorp.com.
 - 2. Mar-Flex Systems, Inc: www.mar-flex.com.
 - 3. W.R. Meadows, Inc: www.wrmeadows.com.
 - 4. Substitutions: See Section 01600 - Product Requirements.

2.02 HOT ASPHALTIC MATERIALS

- A. Bitumen: ASTM D 449, Type I, asphalt.
- B. Primer: ASTM D 41, compatible with substrate.
- C. Sealing Mastic: Asphalt roof cement, ASTM D 4586, Type I.

2.03 COAL TAR MATERIALS

- A. Bitumen: ASTM D 450, Type II, coal tar pitch.
- B. Primer: ASTM D 43, coal tar type.
- C. Sealing Mastic: ASTM D 5643, coal tar roof cement.

2.04 COLD ASPHALTIC MATERIALS

- A. Bitumen: Asphalt emulsion, ASTM D 3747.

- B. Asphalt Primer: ASTM D 41, compatible with substrate.
- C. Sealing Mastic: Asphalt roof cement, ASTM D 2822, Type I.

2.05 ACCESSORIES

- A. Drainage Panel: 1/4 inch thick formed plastic, hollowed sandwich.
- B. Protection Board: Rigid insulation specified in Section 07212.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of dampproofing system.
- C. Verify that items that penetrate surfaces to receive dampproofing are securely installed.

3.02 PREPARATION

- A. Protect adjacent surfaces not designated to receive dampproofing.
- B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.
- C. Do not apply dampproofing to surfaces unacceptable to manufacturer.
- D. Apply mastic to seal penetrations, small cracks, or minor honeycomb in substrate.

3.03 APPLICATION

- A. Prime surfaces in accordance with manufacturer's instructions.
- B. Apply bitumen with mop.
- C. Apply bitumen at a temperature limited by equiviscous temperature (EVT) plus or minus 25 degrees F; do not exceed finish blowing temperature for four hours.
- D. Apply bitumen in one coat, continuous and uniform, at a rate specified by the manufacturer.
- E. Apply from 2 inches below finish grade elevation down to top of footings.
- F. Seal items projecting through dampproofing surface with mastic. Seal watertight.
- G. Place drainage panel directly over dampproofing, butt joints, place to encourage drainage downward.
- H. Scribe and cut boards around projections, penetrations, and interruptions.

END OF SECTION

SECTION 07130**SHEET WATERPROOFING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Sheet membrane waterproofing.
- B. Cant strips and other accessories.
- C. Drainage panels and Protection boards.

1.02 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for membrane.
- C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- D. Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE

- A. Perform Work in accordance with NRCA Roofing and Waterproofing Manual.
- B. Membrane Manufacturer Qualifications: Company specializing in waterproofing sheet membranes with three years experience.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum 10 years experience.

1.04 MOCK-UP

- A. Construct mockup 100 sq ft of horizontal waterproofed panel; to represent finished work including internal and external corners.
- B. Locate where directed.
- C. Mockup may remain as part of the Work.

1.05 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.06 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.
- B. Contractor shall correct defective Work within a five year period after Date of Substantial Completion; remove and replace materials concealing waterproofing at no extra cost to Owner.
- C. Provide five year manufacturer warranty for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Rubber Manufacturers:
 - 1. Carlisle Coatings & Waterproofing, Inc: www.carlisle-ccw.com.
 - 2. Firestone Building Products Co: www.firestonebpco.com.
- B. Acceptable Modified Bituminous Manufacturers:
 - 1. Johns Manville Corporation: www.jm.com.
 - 2. Substitutions: See Section 01600 - Product Requirements.
- C. Other Acceptable Laminated Composite Manufacturers:
 - 1. Grace Construction Products; Product Bituthene 3000: www.na.graceconstruction.com.
 - 2. Substitutions: See Section 01600 - Product Requirements.

2.02 MEMBRANE MATERIALS

- A. Sheet Waterproofing - General: Rubber membrane, loose-laid.
- B. Rubber Membrane: Butylene, conforming to ASTM D 2581.
- C. Modified Bituminous Membrane: Asphalt and polymer modifiers of styrene-butadiene-styrene (SBS) type, reinforced with non-woven polyester; smooth surfaced.
- D. Seaming Materials: As recommended by membrane manufacturer.
- E. Membrane Sealant: As recommended by membrane manufacturer.
- F. Adhesives: As recommended by membrane manufacturer.
- G. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

2.03 ACCESSORIES

- A. Protection Board: Rigid insulation specified in Section 07212.
- B. Drainage Panel: 1/4 inch thick formed plastic, hollowed sandwich.
- C. Cant Strips: Premolded composition material.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.
- C. Verify that items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

- A. Protect adjacent surfaces not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions. Vacuum substrate clean.
- C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.
- D. Seal cracks and joints with sealant using depth to width ratio as recommended by sealant manufacturer.
- E. Surfaces for Adhesive Bonding: Apply surface conditioner at a rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

3.03 INSTALLATION - MEMBRANE

- A. Install membrane waterproofing in accordance with manufacturer's instructions.

- B. Roll out membrane. Minimize wrinkles and bubbles.
- C. Self-Adhering Membrane: Remove release paper layer. Roll out on substrate with a mechanical roller to encourage full contact bond.
- D. Overlap edges and ends and seal by method recommended by manufacturer, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
- E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.
- F. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.
- G. Install flexible flashings. Seal items penetrating through membrane with flexible flashings. Seal watertight to membrane.
- H. Seal membrane and flashings to adjoining surfaces. Install termination bar at all edges. Install counterflashing over all exposed edges.

3.04 INSTALLATION - DRAINAGE PANEL and PROTECTION BOARD

- A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward. Scribe and cut boards around projections, penetrations, and interruptions.
- B. Place protection board directly against drainage panel; butt joints. Scribe and cut boards around projections, penetrations, and interruptions.
- C. Adhere protection board to substrate with compatible adhesive.

3.05 FIELD QUALITY CONTROL

- A. On completion of horizontal membrane installation, dam installation area in preparation for flood testing.
- B. Flood to minimum depth of 1 inch with clean water. After 48 hours, inspect for leaks.
- C. If leaking is found, remove water, repair leaking areas with new waterproofing materials as directed by Owner or Architect; repeat flood test. Repair damage to building.
- D. When area is proven watertight, drain water and remove dam.

3.06 PROTECTION

- A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION

SECTION 07214**FOAMED-IN-PLACE INSULATION****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Foamed-in-place insulation.

1.02 RELATED REQUIREMENTS

- A. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS

- A. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2004.
- B. ASTM C 1029 - Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation; 2007.
- C. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2008.
- D. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Foamed-In-Place Insulation:
 - 1. BASF Polyurethane Foam Enterprises LLC: www.foamenterprises.com.
 - 2. BaySystems: www.baysystemsspray.com
 - 3. BioBased: www.biobased.net
 - 4. Certainteed: www.certainteed.com
 - 5. North Carolina Foam Industries: www.ncfi.com.
 - 6. Substitutions: See Section 01600 - Product Requirements.

2.02 MATERIALS

- A. Insulation: ASTM C 1029, Type I, polyurethane.

2.03 ACCESSORIES

- A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify work within construction spaces or crevices is complete prior to insulation application.
- B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION

- A. Mask and protect adjacent surfaces from over spray or dusting.
- B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

- A. Apply insulation in accordance with manufacturer's instructions.

- B. Apply to achieve a thermal resistance R value of 30.

3.04 FIELD QUALITY CONTROL

- A. Field inspections and tests will be performed by an independent testing agency under provisions of Section 01400.

3.05 PROTECTION

- A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION

SECTION 07411**PREFORMED METAL ROOF PANELS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Architectural roofing system of preformed steel panels.
- B. Fastening system.
- C. Accessories and miscellaneous components.

1.02 RELATED REQUIREMENTS

- A. Section 05120 - Structural Steel: Roof framing and purlins.
- B. Section 06100 - Rough Carpentry: Roof sheathing.
- C. Section 07900 - Joint Sealers: Field-installed sealants.

1.03 REFERENCE STANDARDS

- A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.
- B. ASTM D 226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2006.
- C. ASTM E 1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005.
- D. ASTM E 1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference; 1995 (Reapproved 2003).
- E. ASTM E 1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems; 1995 (Reapproved 2003).
- F. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies; 2006.
- G. American Iron & Steel Institute (AISI) Specification for the Design of Coldformed Steel Structural Members.
- H. SMACNA - Architectural Sheet Metal Manual.
- I. Building Materials Directory - Underwriter's Laboratories, Test Procedure 580.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Summary of test results, indicating compliance with specified requirements.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Specimen warranty.
- C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
 - 1. Show work to be field-fabricated or field-assembled.
- D. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches square, representing actual roofing metal, thickness, profile, color, and texture.
 - 1. Include typical panel joint in sample.
 - 2. Include typical fastening detail.

- E. Test Reports: Indicate compliance of preformed metal roofing system to specified requirements.
- F. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.06 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Design is based on BERRIDGE STANDING SEAM TEE-PANEL, manufactured by Berridge Manufacturing Company, Houston, Texas..
- B. Substitutions: See Section 01600 - Product Requirements.

2.02 ARCHITECTURAL ROOF PANELS

- A. Performance Requirements: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system. Roofing must be Energy Star labeled.
- B. Metal Roofing: Factory-formed panels with factory-applied finish.
 - 1. Roof surfaces with an incline greater than two inches of rise per each 12 inches of horizontal run shall have a minimum reflectance of 0.35 or a minimum SRI of 29.
 - 2. Steel Panels:
 - a. Prefinished Metal shall be Hot-Dipped Galvanized - ASTM A446-85 Grade C G90 Coating A525-86 24 Gauge core steel or prefinished 24 or 22 Gauge Galvalume - ASTM 792-86 AZ-55.
 - b. Unfinished Metal shall be Grade C Galvalume ASTM A792-86, AZ 55, "Satin Finish".
 - c. Finish shall be full strength Kynar 500 PVDF resin-based coating coating, applied by the manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.70 to 0.80 mil over 0.20 to 0.30 mil prime coat, to provide a total topside dry film thickness of 1.0 plus or minus 0.10 mil. Reverse side shall be coated with primer and wash coat of 0.30 mil plus or minus 0.05 mil. Finish shall conform to all tests for adhesion, flexibility, and longevity as specified by the Kynar 500 PVDF resin-based coating supplier.
 - d. Strippable film shall be applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed before installation.
 - 3. Panels shall have 12 3/4" on-center seam spacing with a seam height of 1" and shall have no exposed fasteners.
 - 4. Panels shall be site-formed with the Berridge Model SS-14 Portable Roll Former in continuous lengths from eave to ridge or factory fabricated to 40' max.
 - 5. Snap-on seams shall be 1" in height and shall contain the Berridge factory-applied Extruded Vinyl Weather Seal Insert (Patent No. 4641475) to prevent siphoning of moisture through the standing seam.
 - 6. Concealed anchor clips shall be spaced as required to meet uplift loads (maximum of 24" on center).
 - 7. Texture: Smooth.
 - 8. Width: Maximum panel coverage of 24 inches.

2.03 ATTACHMENT SYSTEM

2.04 ACCESSORIES AND MISCELLANEOUS ITEMS

- A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
- B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish, closed-cell synthetic rubber, neoprene, or PVC, or combination steel and closed-cell foam.
- C. Sealants: As specified in Section 07900.
 - 1. Exposed sealant must cure to rubber-like consistency.
 - 2. Concealed sealant must be non-hardening type.
- D. Underlayment for Wood Substrate: ASTM D 226 roofing felt, perforated type; covered by water-resistant rosin-sized building paper.

2.05 FABRICATION

- A. Panels: Fabricate panels and accessory items at factory, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Broom clean wood sheathing prior to installation of roofing system.
- B. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed roof will be free of leaks.
- C. Remove protective film from surface of roof panels immediately prior to installation. Strip film carefully, to avoid damage to prefinished surfaces.
- D. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by roof panel manufacturer.
- E. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.03 INSTALLATION

- A. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer's instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.
 - 1. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.
- B. Accessories: Install all components required for a complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.

- C. Underlayment: Install roofing felt and building paper slip sheet on roof deck before installing preformed metal roof panels. Secure by methods acceptable to roof panel manufacturer, minimizing use of metal fasteners. Apply from eaves to ridge in shingle fashion, overlapping horizontal joints a minimum of 2 inches and side and end laps a minimum of 3 inches. Offset seams in building paper and seams in roofing felt.
- D. Roof Panels: Install panels in strict accordance with manufacturer's instructions, minimizing transverse joints except at junction with penetrations.

3.04 CLEANING

- A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.05 PROTECTION

- A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.
- B. Touch-up, repair, or replace damaged roof panels or accessories before date of Substantial Completion.

END OF SECTION

SECTION 07500**ROOF BOARD****PART 1 - GENERAL****1.01 Description**

- A. Work in this section includes, but is not limited to:
 - 1. Thermal barrier
 - 2. Roofing protection board
 - 3. Roof insulation protection board
 - 4. Re-cover board
- B. Related work specified elsewhere:
 - 1. Roof insulation
 - 2. Roof membrane

1.02 Submittals

- A. Product data: Submit manufacturer's descriptive literature indicating material composition, thickness, sizes and fire resistance.
- B. Shop drawings: Submit shop drawings indicating fastener and adhesive patterns for FM wind uplift resistance specified.

1.03 Delivery, Storage and Handling

- A. Delivery, Storage & Handling: All materials shall be delivered in their original unopened packages and stored in an enclosed shelter providing protection from damage and exposure to the elements. Outside storage must be off ground and protected by a breathable waterproof covering. Store all panels flat. Damaged materials shall be removed from the premises. Keep Securock™ Roof Board dry before, during and after application. Securock™ Roof Board must be roofed the same day as laid.
- B. Securock™ Roof Boards should be cut to size using utility knife and straight edge. Score surface with utility knife and bend board up sharply toward score. Use Keyhole-Type Utility Drywall Saw for penetration cut-outs and radiuses. For 5/8" Securock™ Roof Board use Drywall Saw.

1.04 Limitations

- A. Securock™ Roof Board has been tested and evaluated for use as a roofing component in properly designed low-slope commercial roof systems. Placement is the responsibility of the designing authority. USG does not offer roofing system design services.
- B. Environmental conditions, application temperatures and techniques, may cause adverse effects with adhered roofing systems. Always consult roofing system manufacturers for their specific instructions on applying their products to Securock™ Roof Board.
- C. Keep panels dry before, during and after installation. Install only as much Securock™ Roof Board as can be covered in the same day by a roof membrane system.
- D. Panel edges and ends should be lightly butted in typical installations. Long, uninterrupted runs of Securock™ Roof Board may require slight gapping due to higher surface temperature gain.
- E. Avoid exposure to water due to leaks or condensation in or on Securock™ Roof Board during and after construction. Do not overuse non-vented, direct-fired heaters during winter months. Abstain from applying Securock™ Roof Board during rains, heavy fogs and other conditions that may deposit moisture on the surface.
- F. Consult the roof membrane manufacturer or roofing systems designer to determine the need, if any, or requirements for a separator sheet when using Securock™ Roof Board with the roofing membrane.

- G. Allow sufficient time for solvent-based adhesives or primers to flash off when applying to avoid damage to roofing components.
- H. Maximum flute span is 2-5/8" for 1/4" Securock™ Roof Board; 5" for 3/8" Securock™ Roof Board; 8" for 1/2" Securock™ Roof Board and 5/8" Securock™ Roof Board.
- I. Do not subject Securock™ Roof Board to abnormal or excessive loads such as heavy steel wheeled equipment that may fracture or damage panels. Provide suitable roofing system protection if required.
- J. Use 1/2" and 5/8" Securock™ Roof Board for vertical framed parapet applications. Space framing a maximum of 24" o.c. with fasteners spaced 8" o.c.
- K. Hot Mopping directly to Securock™ Roof Board:
 - 1. Third-party testing has demonstrated that hot mopping to Securock™ Roof Board is a satisfactory method of bonding membranes.
 - 2. Maximum asphalt application temperatures for Type III asphalt is 450°F. Application temperatures above this recommendation may adversely affect roof system performance.
 - 3. Consult and follow roofing system manufacturer's specifications for full mopping applications and temperature requirements. In case of conflicting recommendations, system manufacturers should prevail.
 - 4. Ribbon or spot mopping or the installation of a perforated base sheet are acceptable methods of bonding asphalt in lieu of full mopping for application temperatures in excess of 450°F and for mopping of type IV asphalt.
 - 5. For questions about the use of Securock™ Roof Board before, during or after the product installation and/or system applications, contact the system manufacturer or the USG Technical Hotline at 1-800-USG-4YOU.
- L. Hot Mopping asphalt or coal tar directly to Securock™ Roof Board: Follow manufacturer's recommended system application temperature guidelines and good roofing practices.
- M. Torch applied directly to Securock™ Roof Board;
 - 1. Securock™ Roof Board is the preferred substrate for torch application. *
 - 2. Ensure proper torching technique and control the majority of the torch flame directly on the roll. Limit the flame and heat to the surface of Securock™ Roof Board.
- N. Confirm any priming requirements with membrane manufacturer. Field priming may not be necessary with a number of systems. *

PART 2 - PRODUCTS

2.01 Gypsum Roof Board:

- A. Securock™ Roof Board
 - 1. Acceptable product and manufacturer: USG Corporation, 1/4" Securock™ Roof Board, 3/8" Securock™ Roof Board 1/2" Securock™ Roof Board and 5/8" Securock™ Roof Board.
 - 2. Composition: Impact-resistant, nonstructural, specially engineered gypsum and cellulose fiber panels with 95% certified recycled content. Uniform water-resistance throughout core and surface.
 - 3. Size: Nominal 4' x 8', 4' x 4'
Edges: Square
Facers: None
Squareness: ± 1/8"
 - 4. Thickness: 1/4", 3/8", 1/2" Securock™ Roof Board and 5/8" Securock™ Roof Board (Type X).
 - 5. Fire Resistance:
 - a. Flame spread 5, smoke developed 0, when tested in accordance with ASTM E84
 - b. 5/8" Securock™ Roof Board UL -classified Type FRX-G when tested in accordance with ASTM E119.
 - c. Class A when tested to UL 790.
 - d. Code alternate to 15 minute thermal barrier as tested to UL 1256.

6. Perms: Permeance per ASTM C473:
 - a. 1/4", 3/8", 1/2", and 5/8" Securock™ Roof Board ? 30 perms.
7. Surface water absorption: Nominal grams per ASTM C473:
 - a. 1/4", 3/8", 1/2", and 5/8" Securock™ Roof Board ? 1.6 grams.
8. Water resistance: Weight percentage gain:
 - a. Maximum 10%.
9. Mold Resistance: Minimum rating of "10" in accordance with ASTM D3273.

2.02 Miscellaneous Materials

- A. FM-approved plates and fasteners: Provide size and type in accordance with FM requirements and roof system manufacturer's written recommendations.
- B. Adhesives: As recommended by roof system manufacturer.

PART 3 - EXECUTION

3.01 General

- A. Provide Securock™ Roof Board where indicated on drawings using fastening system specified.
- B. Use maximum lengths possible to minimize number of joints. Support edge joints with deck ribs. Stagger end joints of adjacent lengths of Securock™ Roof Board.

3.02 Roof Board Installation

- A. Adhered Systems: As recommended by roof system and adhesive manufacturers.
- B. Mechanically Attached Systems: Install per FM guidelines for wind uplift resistance.

3.03 Parapet (Wall) Framing and Fastening

- A. Use appropriate corrosion-resistant fasteners as defined by roof system manufacturer.
- B. Maximum parapet framing spacing: 24" o.c. for 1/2" or 5/8" Securock™.
- C. Fasten a maximum 12" o.c. around the perimeter and 12" o.c. in the field. Minimum fastener penetration in wood framing is 3/4" and in steel framing is 3/8".

STANDARDS AND CODE COMPLIANCE

SECUROCK™ ROOF BOARD IS MANUFACTURED TO CONFORM TO ASTM C1278 AND MEETS FACTORY MUTUAL 4470 CLASS 1 CRITERIA AS A THERMAL BARRIER OR OVERLAYMENT BOARD. IN ACCORDANCE WITH FM WIND UPLIFT RESISTANCE STANDARDS, 1/4" SECUROCK™ ROOF BOARD SURPASSES THE PASSING PRESSURE VALUES OF SIMILAR 5/8" THICK GLASS-FIBER COVER BOARDS. CONSULT WITH YOUR LOCAL USG SALES REPRESENTATIVE FOR DETAILS.

SECUROCK™ ROOF BOARDS ARE APPROVED WITH FLORIDA BUILDING CODE FOR INSTALLATION OVER INSULATED OR NON-INSULATED, NEW OR EXISTING WOOD, STEEL, CONCRETE OR CEMENTITIOUS WOOD FIBER ROOF DECKS OR INSULATED OR NON-INSULATED EXISTING GYPSUM ROOF DECKS. THEY MAY BE MECHANICALLY ATTACHED OR APPLIED IN ASTM D312, TYPE III OR IV HOT ASPHALT, ASTM D6152 SEBS MODIFIED ASPHALT, OR OTHER APPROVED INSULATION ADHESIVE.

5/8" SECUROCK™ ROOF BOARDS ARE CLASSIFIED BY UNDERWRITERS LABORATORIES AND MAY BE USED IN MANY UL FIRE-RATED "P" DESIGNS.

SECUROCK™ ROOF BOARDS ARE TO BE USED IN LOW-SLOPE COMMERCIAL ROOF CONSTRUCTION INCLUDING THOSE SYSTEMS CLASSIFIED IN UL790 AS CLASS A, B, OR C.

SECUROCK™ ROOF BOARDS ARE CERTIFIED 95% RECYCLED CONTENT BY SCIENTIFIC CERTIFICATION SYSTEMS.

END OF SECTION

SECTION 07560**FLUID APPLIED ROOFING****PART 1 GENERAL****1.01 DESCRIPTION**

- A. Fluid applied flexible acrylic waterproofing systems over a concrete deck and/or roof board. This work shall include the preparation of the deck, application of the waterproofing products, flashing system, and clean up.

1.02 SUBSTRATE APPROVAL

- A. All Hydro-Stop Inc. warranted jobs over any substrate must have substrate approval prior to job start up. Hydro-Stop Inc. may require an approved recovery board with roof breathers over certain concrete type decks. Please consult your local Technical Representative for assistance and approval.

1.03 RELATED WORK

- A. The contractor shall review all sections of these specifications to determine items of work that will interface with the application of this decking system. Coordination and execution of related sections shall be the responsibility of the contractor.

1.04 REFERENCES

- A. ASTM G-29 - Test Methods for Algae Resistance.
- B. ASTM E-108 - Test Method for Fire Test of Roof Coverings.
- C. ASTM D-1653 - Water Vapor Transmission of Materials.
- D. ASTM G-26 - Practice for Operating Light- and Water-Exposure Apparatus (Xenon Arc Type) for Exposure of Non-metallic Materials.
- E. ASTM D-412- Ultimate Tensile Strength at Break
- F. ASTM D-6083- Standard Specification for Liquid Applied Acrylic Coatings used in roofing

1.05 SUBMITTALS

- A. Shop Drawings: Submit a scaled drawing showing the layout of joint reinforcing and all flashing details.
- B. Product Data: Provide manufacturer's technical literature on products that make up the decking system. This shall include, but is not limited to, coatings, reinforcing fabrics, flashing materials, fasteners, etc..
- C. Manufacturer's Installation Instructions: Submit all data sheets available from the manufacturer on the installation of the decking system applicable to the work.
- D. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.06 QUALIFICATIONS

- A. Applicator Qualifications: The applicator of the decking material specified herein shall be an approved applicator (designated by Hydro-Stop Inc.). Proof of this qualification shall be provided in written form from the manufacturer of the decking system.

1.07 QUALITY CONTROL

- A. Codes and Standards: The contractor shall make him/herself thoroughly familiar with all codes, regulations, and standards governing the specified work. Any contradiction between the manufacturer's requirements and these specifications shall be brought to the attention of the manufacturer and the specifier

- B. Deviations: There shall not be any deviations from these specifications unless the deviation is submitted in writing to the specifier. The request for deviation must have a letter from the decking manufacturer's technical department approving the details of the deviation.
- C. An Approved Applicator (as designated by Hydro-Stop Inc.) shall be on site during all applications of any Hydro-Stop products.
- D. Manufacturer's Technical Representative: An employee of the decking material manufacturer shall be on site at least once every 7-calendar days during the work specified herein. Upon request the technical representative shall provide a written inspection report, during each site visit and submit the reports to the owner/owner's representative. The manufacturer's representative will only inspect the installation of the Hydro-Stop products and not the application of the tile or thin set.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's unopened and undamaged containers bearing the following information:
 1. Name of manufacturer.
 2. Name of contents and products code.
 3. Net volume of contents.
 4. Lot or batch number.
 5. VOC content
 6. Storage temperature limits.
 7. Shelf life expiration date.
 8. Mixing instructions and proportions of contents.
 9. Safety information and instructions.
 10. Store and protect materials from damage and weather in accordance with manufacturer's instructions.
 11. Store materials at temperatures between 50 and 90 degrees F (10 and 32 degrees C). Keep out of direct sunlight.
 12. Support stored material containers on pallets and cover with tarpaulin tied to bottom of pallets.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply if ambient temperatures are expected to fall below 40 degrees F (4.5 degrees C) or if rain is expected before the application has time to dry.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Hydro-Stop, Inc. www.hydro-stop.com Phone: (843) 745-9600

2.02 MEMBRANE COMPOUND MATERIAL

- A. Waterproofing Material: PremiumCoat three-stage, fabric reinforced, flexible acrylic coating, fluid applied in successive stages to form one continuous, seamless, watertight membrane; 40 mil (.04 inches / 1.016 millimeters) minimum cured total system thickness; comprised of the following:
 1. Foundation and Saturation Coats: PremiumCoat FoundationCoat (highly flexible water based 100% pure acrylic polymer resin coatings).
 2. Fabric: Hydro-Stop polyester, non-woven, stitch-bonded, and heat-set fabric.
 3. Finish Coat: PremiumCoat FinishCoat (ultraviolet light resistant, blend of highly flexible water based 100% pure acrylic polymer resin coating); color as selected from manufacturer's standard colors.
- B. Reinforcing Fabric: This material shall be non-woven 100% polyester, stitch bonded, heat set fabric with the following characteristics:

1. Weight:	3 oz / per square yard	(106.31 grams / square meter)	
Tensile Strength	Warp 74 lbs.	(33.60 kg)	per ASTM D 5034
	Fill 45 lbs.	(20.43 kg)	

2.	Elongation @ Break	Warp 21.3%		per ASTM D 5034
		Fill 51.3%		
3.	Ball Burst	111 lbs.	(50.39 kg)	per ASTM D 3787
4.	Trapezoid	Warp 13.5 lbs.	(6.13 kg)	per ASTM D 117
		24.2 lbs.	(10.99 kg)	
5.	Thickness	.018 inches	(.457 mm)	per ASTM D-1777
6.	Cured Membrane Characteristics:			

PROPERTY	TEST	RESULT
Elongation	ASTM D638	>300% elastomeric, 50% w/ reinforcing fabric
Tensile Strength (cured)	ASTM D412	>2000 PSI (13,789 kPA)
Algae Resistance	ASTM G29	No Growth Supported
Moisture Vapor	ASTM E96	3 Perms
Weathering	ASTM G26	No effect after 3,000 hours.45 lbs.
Salt Spray Test	ASTM B117	No effect.
Fire Rating	ASTM E108	Class A
Wind Uplift	FM 4470	Meets Class 1- 90
Severe Hail Test	FM 4470	No separation or rupture 1-SH
Liquid Applied Acrylic	ASTM D6083	Approved

2.03 ACCESSORIES

- A. Surface Primer: Hydro-Stop BarrierGuard cementitious waterproofing sealer for concrete.
- B. Cant Strips: Recommended composition materials are EPS (Expanded Polystyrene), ISO (Polyisocyanurate), and wood (non-treated). Cant strips are to be installed at all internal corners, around curbs, and at all 90 degree angles specified by Hydro-Stop Inc.
- C. Moisture Breathers: Install moisture breathers as recommended by Hydro-Stop Inc. Technical Personal.
- D. Hydro-Fiber: Bulking material used in conjunction with Foundation Coat or BarrierGuard slurry (as specified by Hydro-Stop Technical Representative) to fill cracks, voids, or low depressions on various substrates.
- E. StableRust Primer: water based surfactant-free primer used in direct metal applications to stabilize and protect metal surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify substrate surfaces are durable, free of frozen matter, dampness, loose particles, cracks, pits, projections, or foreign matter detrimental to adhesion or application of waterproofing system.
- B. Verify that substrate surfaces are smooth and not detrimental to full contact bond of waterproofing materials.
- C. Verify items that penetrate surfaces to receive waterproofing are securely installed.
- D. Verify that substrate areas are adequately supported and firmly fastened in place.
- E. Verify that deck has a minimum slope of .25 inch / foot (2.083cm/meter)
- F. Verify that deck does not have ponding water areas.
- G. Verify that all attached vertical walls are properly waterproofed.
- H. Verify that ph of existing concrete deck is between 6-8.

3.02 PREPARATION

- A. Protect adjacent surfaces not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing by removing all loose and flaking particles, grease

and laitance with the use of a stiff bristle push broom and or washing. Prevent the injection of water into the substrate during washing. Additional drying time may be required after the cleaning process. Consult Hydro-Stop Inc. for additional advice on cleaning various roofing substrates.

- C. Make all necessary repairs to existing substrate. Contact Hydro-Stop for assistance.
- D. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer.

3.03 APPLICATION

- A. Surface Primer- Mix BarrierGuard slurry in accordance with manufacturer's instructions and apply over masonry surface at a minimum coverage rate of 150 ft²/ gal (3.57 m²/ liter)
- B. Foundation Coat & Fabric Components- Consist of one coat of FoundationCoat applied to the substrate, Hydro-Stop PremiumCoat Fabric (sizes vary) laid into the wet FoundationCoat, and finally a second coat of FoundationCoat saturating the fabric from above. Care should be given to ensure that adjacent runs of fabric are overlapped a minimum of 4 inches (10.16 cm). Foundation Coats are applied at a total rate of 25-40 ft²/gal (.594 - .951 m²/liter) depending on substrate. FoundationCoat should only be applied with the use of approved roof brushes. Rolling and spraying of the FoundationCoat are absolutely forbidden.
 - 1. Roof Perimeter- Using 12 inch (30.48 centimeters) fabric and the Foundation components (described above), waterproof entire roof perimeter. Continue waterproofing up vertical surfaces and onto deck a minimum of 6 inches (15.24 centimeters) in each direction.
 - 2. Roof Penetrations- Using 12 inch (30.48 centimeters) fabric and the Foundation components (described above) seal items projecting through waterproofing material watertight. Waterproof up penetrations a minimum of 6" (15.24 centimeters)
 - 3. Roof Field- Using 40 in. (1.016 m) fabric and the Foundation components (as described above) seal the entire roof field. Overlap adjacent runs of fabric 4 inches (10.16 cm) minimum.
- C. Finish Coat Component- Apply 2 coats of FinishCoat at a combined total rate of 70 ft²/gal (1.664 m²/liter) over entire roof area. Minimum milage requirements are 10-11 mils (.010-.011 inches / .254-.279 millimeters) wet and 7.5 mils (.0075 inches / .191 millimeters) dry per coat. Allow to dry between coats. Total Finish Coat dry thickness should be a minimum of 15 mils (.015 inches / .381 millimeters).
- D. Completed PremiumCoat System- System must be installed to a minimum 40 mil (.04 inches / 1.016 millimeters) total cured thickness.
- E. BarrierGuard Application-
 - 1. Mix waterproofing slurry material in accordance with manufacturer's instructions.
 - 2. Apply 1st coat of waterproofing slurry and embed fabric into still wet slurry coat followed by a saturation coat of slurry, and allow to dry. Total application rate for both foundation and saturation coats of waterproofing slurry is to be 25-sq. ft/gal (0.6-sq. m/L).
 - 3. The PremiumCoat fabric should be installed in the above manner ensuring that side laps and end laps overlap 4 inches (100 mm).
 - 4. Apply a final coat of waterproofing slurry at a coverage rate of 70 sq. ft / gal (1.7 sq. m/L) and allow to cure for at least 48 hours before allowing the installation of tile, mortar, or thin set.
- F. Tile Application - All specifications pertaining to the installation of tile should be obtained from the manufacturer of the tile that is used.

3.04 PROTECTION OF FINISHED WORK

- A. Monitor finished system for 7 day, sweeping off birdbaths to allow for full cure.

3.05 CLEANING

- A. Clean unscheduled surfaces receiving waterproofing in accordance with manufacturer's instructions.

END OF SECTION

SECTION 07620**SHEET METAL FLASHING AND TRIM****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Fabricated sheet metal items, including flashings and counterflashings.
- B. Reglets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07411 - Preformed Metal Roof Panels: Roofing system.
- B. Section 07560 - Fluid Applied Roofing: Roofing system
- C. Section 07631 - Gutters and Downspouts.
- D. Section 07900 - Joint Sealers.
- E. Section 09900 - Paints and Coatings: Field painting.

1.03 REFERENCE STANDARDS

- A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.
- B. ASTM D 4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007.
- C. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2003.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS**2.01 SHEET MATERIALS**

- A. Galvanized Steel: ASTM A 653/A 653M, with G90/Z275 zinc coating; minimum 0.02 inch thick base metal.

2.02 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Primer: Zinc chromate type.
- C. Protective Backing Paint: Zinc molybdate alkyd.
- D. Plastic Cement: ASTM D 4586, Type I.

2.03 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.

- C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
- F. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.
- G. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION

- A. Insert flashings into reglets to form tight fit. Secure in place with lead wedges. Pack remaining spaces with lead wool. Seal flashings into reglets with sealant.
- B. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
- C. Apply plastic cement compound between metal flashings and felt flashings.
- D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- E. Seal metal joints watertight.

3.04 FIELD QUALITY CONTROL

- A. See Section 01400 - Quality Requirements, for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 07631**GUTTERS AND DOWNSPOUTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Pre-finished galvanized steel gutters and downspouts.

1.02 RELATED REQUIREMENTS

- A. Section 07620 - Sheet Metal Flashing and Trim.

1.03 REFERENCE STANDARDS

- A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.
- B. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2003.

1.04 DESIGN REQUIREMENTS

- A. Conform to applicable code for size and method of rain water discharge.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.
- C. Product Data: Provide data on prefabricated components.
- D. Samples: Submit two samples, 6 inch long illustrating component design, finish, color, and configuration.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Pre-Finished Galvanized Steel Sheet: ASTM A 653/A 653M, with G90/Z275 zinc coating; minimum 0.02 inch thick base metal.
 - 1. Color: As selected from manufacturer's standard colors.

2.02 COMPONENTS

- A. Gutters: SMACNA semi-circular style profile.
- B. Downspouts: CDA Round profile.
- C. Anchors and Supports: Profiled to suit gutters and downspouts.
 - 1. Anchoring Devices: Type recommended by fabricator.
 - 2. Gutter Supports: Brackets.
- D. Fasteners: Galvanized steel, with soft neoprene washers.

2.03 ACCESSORIES

- A. Downspout Boots: Cast iron.

2.04 FABRICATION

- A. Form gutters and downspouts of profiles and size indicated.
- B. Fabricate with required connection pieces.
- C. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.
- D. Hem exposed edges of metal.
- E. Fabricate gutter and downspout accessories; seal watertight.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.

3.02 PREPARATION

- A. Paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION

- A. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions.
- B. Sheet Metal: Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts and accessories.
- C. Slope gutters 1/8 inch per foot.
- D. Connect downspouts to downspout boots at 24 above grade. Grout connection watertight.
- E. Connect downspouts to storm sewer system. Grout connection watertight.

END OF SECTION

SECTION 07720**ROOF ACCESSORIES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Manufactured curbs, equipment rails, and pedestals.

1.02 REFERENCE STANDARDS

- A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Installation methods.
 - 2. Maintenance requirements.

PART 2 PRODUCTS**2.01 MANUFACTURED CURBS**

- A. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies:
 - 1. AES Manufacturing Inc.: www.aescurb.com.
 - 2. The Pate Company: www.patecurbs.com.
 - 3. RPS Accessories: www.rpscurbs.com.
- B. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies: Factory-assembled hollow sheet metal construction with fully mitered and welded corners, integral counterflashing, internal reinforcing, and top side and edges formed to shed water.
 - 1. Sheet Metal: Hot-dip zinc coated steel sheet complying with ASTM A 653/A 653M, SS Grade 33 ; G60 coating designation; 18 gage, 0.048 inch thick.
 - 2. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing insulation; 1:1 slope; minimum cant height 4 inches.
 - 3. Manufacture curb bottom and mounting flanges for installation directly on roof deck, not on insulation; match slope and configuration of roof deck.
 - 4. Provide the layouts and configurations shown on the drawings.
- C. Curbs Adjacent to Roof Openings: Provide curb on all sides of opening, with top of curb horizontal for equipment mounting.
 - 1. Provide preservative treated wood nailers along top of curb.
 - 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 - 3. Height Above Finished Roof Surface: 6 inches, minimum.
 - 4. Height Above Roof Deck: 14 inches, minimum.
- D. Equipment Rails: Two-sided curbs in straight lengths, with top horizontal for equipment mounting.
 - 1. Provide preservative treated wood nailers along top of rails.
 - 2. Height Above Finished Roof Surface: 6 inches, minimum.
 - 3. Height Above Roof Deck: 14 inches, minimum.
- E. Pipe, Duct, and Conduit Mounting Pedestals: Vertical posts, minimum 8 inches square unless otherwise indicated.
 - 1. Provide sliding channel welded along top edge with adjustable height steel bracket, manufactured to fit item supported.
 - 2. Height Above Finished Roof Surface: 6 inches, minimum.
 - 3. Height Above Roof Deck: 14 inches, minimum.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07900**JOINT SEALERS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Sealants and joint backing.
- B. Precompressed foam sealers.
- C. Hollow gaskets.

1.02 RELATED REQUIREMENTS

- A. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 08630 - Metal-Framed Skylights: Structural and weatherseal sealants and accessories.
- C. Section 08800 - Glazing: Glazing sealants and accessories.
- D. Section 09260 - Gypsum Board Assemblies: Acoustic sealant.
- E. Section 09300 - Tile: Sealant used as tile grout.

1.03 REFERENCE STANDARDS

- A. ASTM C 834 - Standard Specification for Latex Sealants; 2005.
- B. ASTM C 919 - Standard Practice for Use of Sealants in Acoustical Applications; 2002.
- C. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants; 2005.
- D. ASTM C 1193 - Standard Guide for Use of Joint Sealants; 2005a.
- E. ASTM D 1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2007.
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with other sections referencing this section.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.
- C. Samples: Submit two samples, illustrating sealant colors for selection.
- D. LEED Report: Submit VOC content documentation for all non-preformed sealants and primers.
- E. Manufacturer's Installation Instructions: Indicate special procedures.

1.06 MOCK-UP

- A. Provide mock-up of sealant joints in conjunction with window and wall under provisions of Section 01400.
- B. Construct mock-up with specified sealant types and with other components noted.
- C. Locate where directed.
- D. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.08 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 SEALANTS

- A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. General Purpose Exterior Sealant: Polyurethane; ASTM C 920, Grade NS, Class 25, Uses M, G, and A; single component.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Applications: Use for:
 - a. Control, expansion, and soft joints in masonry.
 - b. Joints between concrete and other materials.
 - c. Joints between metal frames and other materials.
 - d. Other exterior joints for which no other sealant is indicated.
- C. Exterior Expansion Joint Sealer: Precompressed foam sealer; urethane with water-repellent;
 - 1. Color: Black.
 - 2. Size as required to provide weathertight seal when installed.
 - 3. Provide product recommended by manufacturer for traffic-bearing use.
 - 4. Applications: Use for:
 - a. Exterior wall expansion joints.
- D. Exterior Metal Lap Joint Sealant: Butyl or polyisobutylene, nondrying, nonskinning, noncuring.
 - 1. Applications: Use for:
 - a. Concealed sealant bead in sheet metal work.
 - b. Concealed sealant bead in siding overlaps.
- E. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NF single component, paintable.
 - 1. Color: Standard colors matching finished surfaces as chosen by Architect.
 - 2. Applications: Use for:
 - a. Interior wall and ceiling control joints.
 - b. Joints between door and window frames and wall surfaces.
 - c. Other interior joints for which no other type of sealant is indicated.
- F. Bathtub/Tile Sealant: White silicone; ASTM C 920, Uses I, M and A; single component, mildew resistant.
 - 1. Applications: Use for:
 - a. Joints between plumbing fixtures and floor and wall surfaces.
 - b. Joints between kitchen and bath countertops and wall surfaces.
- G. Acoustical Sealant: Butyl or acrylic sealant; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
 - 1. Applications: Use for concealed locations only:
 - a. Sealant bead between top stud runner and structure and between bottom stud track and floor.

- H. Interior Floor Joint Sealant: Polyurethane, self-leveling; ASTM C 920, Grade P, Class 25, Uses T, M and A; single component.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Applications: Use for:
 - a. Expansion joints in floors.
- I. Concrete Paving Joint Sealant: Polyurethane, self-leveling; ASTM C 920, Class 25, Uses T, I, M and A; single component.
 - 1. Color: Gray.
 - 2. Applications: Use for:
 - a. Joints in sidewalks and vehicular paving.

2.02 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.02 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C 1193.
- C. Perform acoustical sealant application work in accordance with ASTM C 919.
- D. Install bond breaker where joint backing is not used.
- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- G. Tool joints concave.
- H. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

3.03 CLEANING

- A. Clean adjacent soiled surfaces.

3.04 PROTECTION

- A. Protect sealants until cured.

END OF SECTION

SECTION 08110**STEEL DOORS AND FRAMES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Non-fire-rated steel doors and frames.
- B. Steel frames for wood doors.
- C. Fire-rated steel doors and frames.
- D. Thermally insulated steel doors.
- E. Sound-rated steel doors and frames.
- F. Steel glazing frames.
- G. Accessories, including glazing, louvers, and matching panels.

1.02 RELATED REQUIREMENTS

- A. Section 08710 - Door Hardware.

1.03 REFERENCE STANDARDS

- A. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.
- B. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 2003.
- C. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 1998 (R2004).
- D. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.
- E. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2004.
- F. ASTM E 413 - Classification for Rating Sound Insulation; 2004.
- G. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2006.
- H. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2007.
- I. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association; 2007.
- J. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.
- K. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; 1998.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
- D. Samples: Submit two samples of metal, 2 x 2 inches in size showing factory finishes, colors, and surface texture.

- E. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Maintain at the project site a copy of all reference standards dealing with installation.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with NAAMM HMMA 840.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 DOORS AND FRAMES

- A. Requirements for All Doors and Frames:
 - 1. Accessibility: Comply with ANSI/ICC A117.1.
 - 2. Door Top Closures: Flush with top of faces and edges.
 - 3. Door Edge Profile: Beveled on both edges.
 - 4. Door Texture: Smooth faces.
 - 5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
 - 6. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
 - 7. Galvanizing for Units in Wet Areas: All components hot-dipped zinc-iron alloy-coated (galvannealed), manufacturer's standard coating thickness.
 - 8. Finish: Factory primed, for field finishing.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.02 STEEL DOORS

- A. Exterior Doors:
 - 1. Grade: ANSI A250.8 Level 3, physical performance Level A, Model 2, seamless.
 - 2. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A 653/A 653M, with manufacturer's standard coating thickness.
- B. Interior Doors, Non-Fire-Rated:
 - 1. Grade: ANSI A250.8 Level 1, physical performance Level C, Model 1, full flush.
 - 2. Thickness: 1-3/4 inches.
- C. Interior Doors, Fire-Rated:
 - 1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 1, full flush.
 - 2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure").
 - a. Provide units listed and labeled by UL.
 - b. Attach fire rating label to each fire rated unit.
- D. Interior Doors, Sound-Rated:
 - 1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
 - 2. STC Rating of Assembled Door, Frame, and Seals: 35, calculated in accordance with ASTM E 413, tested in accordance with ASTM E 90 or ASTM E 1408.
 - 3. Sound Seals: Integral, concealed in door or frame.

4. Force to Open and Close and Latch: Not more than 5 pounds.

E. Panels: Same construction, performance, and finish as doors.

2.03 STEEL FRAMES

A. General:

1. Comply with the requirements of grade specified for corresponding door, except:

a. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 1, 18 gage

b. Frames for Sound-Rated Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 1, 16 gage

2. Finish: Same as for door.

B. Exterior Door Frames: Face welded, seamless with joints filled.

1. Weatherstripping: Separate, see Section 08710.

C. Interior Door Frames, Non-Fire-Rated: Face welded type, seamless with joints filled.

D. Interior Door Frames, Fire-Rated: Face welded type.

1. Fire Rating: Same as door, labeled.

E. Sound-Rated Door Frames: Face welded type.

F. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

2.04 ACCESSORY MATERIALS

A. Louvers: Roll formed steel with overlapping frame; factory-painted finish, color as selected; factory-installed.

1. In Fire-Rated Doors: UL-listed fusible link louver, same rating as door.

B. Glazing: As specified in Section 08800, factory installed.

C. Astragals for Double Doors: Specified in Section 08710.

1. Fire-Rated Doors: Steel, shape as required to accomplish fire rating.

D. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.

E. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.05 FINISH MATERIALS

A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

3.02 INSTALLATION

A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840. Install plumb and square.

B. In addition, install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.

D. Coordinate installation of hardware.

E. Touch up damaged factory finishes.

3.03 TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Adjust sound control doors so that seals are fully engaged when door is closed.
- C. Test sound control doors for force to close, latch, and unlatch in accordance with ASTM E 1408; adjust as required to comply.

END OF SECTION

SECTION 08210**FLUSH WOOD DOORS****PART 1. GENERAL****1.01 SECTION INCLUDES**

- A. Wood doors non-rated and fire-rated .
- B. Flush
- C. Glazed
- D. Louvers
- E. Neutral and Positive Pressure rated fire doors
- F. STC

1.02 RELATED SECTIONS

- A. Section 01 33 00 - Submittal Procedures
- B. Section 06 20 00 - Finish Carpentry
- C. Section 06 40 00 - Architectural Woodwork
- D. Section 08 11 00 - Metal doors and frames
- E. Section 08 70 00 - Finish hardware
- F. Section 08 80 00 - Glazing
- G. Section 08 91 26 - Louvers

1.03 REFERENCES AND REGULATORY REQUIREMENTS

- A. NFPA 252 - Standard Methods for Fire Assemblies.
- B. UBC 7-2, 1997
- C. UL 10 B - Fire Tests for Door Assemblies - Neutral Pressure [or] UL 10 C - Fire Tests for Door Assemblies - Positive Pressure
- D. NFPA 80 - Fire Doors and Windows.
- E. Quality Standards:
 - 1. WDMA Industry Standard I.S. 1-A-04 (Window and Door Manufacturers Association) [or]
 - 2. AWI Quality Standards 8th Edition, Version 2.0 2005 [or] select AWI QCP program [or] WI Manual of Millwork, 11th Edition, 2003
 - 3. ANSI A115. W Series, Wood Door Hardware Standards. (American National Standard Institute)
 - 4. LEED NC version 3
 - a. Door Construction: [recommendation for maximum LEED contributions]
 - b. Core: Solid FSC certified particleboard core conforming to ANSI 208.A LD-2 consisting of recycled fiber with no added urea-formaldehyde bonding resins. LEED Credits MR 4.1, MR 4.2, MR 7, EQ 4.4
 - c. Stiles: Exposed surface same species as or compatible to face veneer. Glued to core. No added urea-formaldehyde in wood components and adhesives. LEED Credit EQ 4.4
 - d. Top and Bottom Rails: Mill option hardwood or SCL glued to core. 5", 8" and 12" optional. No added urea-formaldehyde in wood components and adhesives. LEED Credit EQ 4.4
 - e. Crossbanding: high-density fiberboard consisting of recycled fibers with no added urea-formaldehyde. LEED Credit MR 4.1, MR 4.2 and EQ 4.4.
 - f. Adhesives: Glue lines for assembly between the plies of face, crossbanding and core are to be Type 1 polyvinyl acetate (PVA). LEED Credit EQ 4.4

- F. Labeling Agencies
 - 1. Underwriters Laboratories, Inc. (UL) (Neutral pressure and Positive pressure rated doors)
 - 2. Intertek Testing Services-Warnock Hersey (ITS-WH) (Ratings for both Neutral pressure and Positive pressure rated doors)

1.04 1.4 SUBMITTALS

- A. Submit under provisions of AWI Section 1300 or WDMA I.S. 1-A-04.
- B. Shop drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts, special bevels, blocking for hardware in mineral core doors, identify cutouts.
- C. Indicate compliance with positive pressure.
- D. Product Data: Indicate door core materials, thickness, construction, veneer species: Birch
- E. Construction samples: Submit one or more of manufacturer's standard samples demonstrating door construction.
- F. Finish samples: illustrating the range of color and grain of the specified door face materials.
- G. Manufacturer's full lifetime warranty

1.05 QUALITY ASSURANCE

- A. Meet or exceed AWI Version 2.0 Custom Grade.
- B. Labeled Doors: Listed and conform to the requirements of:
 - 1. Underwriters Laboratories (UL). [or]
 - 2. Intertek Testing Services-Warnock Hersey (ITS-WH)

1.06 DELIVERY STORAGE AND HANDLING AND SITE CONDITIONS

- A. Deliver, store, protect and handle products under provisions of AWI and manufacturer's care and handling instructions.
- B. Accept doors on site in manufacturer's standard packaging. Inspect for damage. Do not store in damp or wet areas. HVAC systems must be operating and balanced prior to arrival of doors. Acceptable humidity shall be no less than 25% or greater than 55%.
- C. Certain wood species are light sensitive. Protect doors from exposure to natural and artificial light after delivery.

1.07 COORDINATION

- A. Coordinate work under provisions of Section 01620.
- B. Coordinate the work with door opening construction, door frame and door hardware installation with a pre-installation conference.

1.08 1.8 WARRANTY

- A. Provide manufacturer's warranty to the following term:
 - 1. Interior Solid Core Doors: "Full Life of Original Installation" including rehang and refinish if door(s) do not comply with warranty tolerance standards.
 - 2. Include coverage for delamination, warping, bow, cup and telegraphing of core construction beyond warranty tolerances.

PART 2. PRODUCTS

2.01 MANUFACTURER

- A. Eggers Industries, 5-ply bonded construction door quality as defined in this section.
 - 1. Other acceptable manufacturers of 5 ply bonded construction doors:
 - a. Graham Wood Doors: www.grahamdoors.com.

- b. Haley Brother: www.haleybros.com
- c. Substitutions allowed only if approved by the architect prior to bid date.

2.02 MATERIALS

- A. WORKMANSHIP
 - 1. Comply with [Choose One] WDMA [or] AWI [or] WI workmanship for veneer faces, vertical edges, crossbands, horizontal edges and dimensional tolerances.
 - 2. Meeting or exceeding Heavy Duty [or] Extra Heavy Duty Performance Level
- B. DOOR CONSTRUCTION GRADE
 - 1. Except as may be otherwise shown on the drawings fabricate the work of this section to WDMA "Premium Grade" [or] AWI "Custom Grade" and WI "Custom Grade" for PC-5 bonded particleboard core.
- C. FLUSH DOOR FACING
 - 1. Wood Veneer: Birch
- D. VENEER MATCHING
 - 1. Book Match
- E. ASSEMBLY OF SPLICED VENEERS
 - 1. Running book match
- F. DOORS IN PAIRS OR SETS
 - 1. Pair Match required at pairs
 - 2. Doors located within six inches of each other shall be pair matched
 - 3. Door schedule shall reflect pairs and sets by door numbers, including doors separated by a mullion.

2.03 FABRICATION

- A. DOOR AND TRANSOM PANEL CORE CONSTRUCTION
 - 1. Non-rated:
 - a. ANSI A208.1-LD-2 Particleboard, PB;
 - b. Structural Composite Lumber; SCL
 - c. Staves with one species per core SLC
 - 2. 20-minute fire-rating:
 - a. Neutral Pressure
 - b. Positive Pressure:
 - 1) Category A (concealed intumescent) [or]
 - 2) Category B (frame mounted intumescent)
 - c. ANSI A208.1-LD-2, Particleboard; PB
 - d. Structural Composite Lumber; SCL-20
 - e. Staves with one species per core; SLC-20
 - 3. 45-, 60- or 90-minute mineral core fire-rated:
 - a. Neutral Pressure
 - b. Positive Pressure:
 - 1) Category A (concealed intumescent) [or]
 - 2) Category B (frame mounted intumescent)
 - c. Modify or omit this listing to meet your project requirements. Specify STC rating required.
 - 4. Acoustical: The Sound Transmission Class (STC) specified shall be certified by the manufacturer to be based on tests conducted at an independent testing agency in accordance with ASTM E90-90 and E413-87. Earlier tests not acceptable. Acoustical Doors with lites to be factory glazed to maintain STC rating. Door may be fire labeled if specified. [STC Ratings 28-51 available]
- B. Optional Lite, Louver and Astragal Details:
 - 1. Lite openings shall be furnished with same species wood lite beads.
 - 2. Louvers in non-rated doors shall be wood.

- a. Wood louvers shall be manufacturer's standard construction. Louvers shall be the same species lumber as the door face and be factory installed. Wood louvers shall be Single slat.
 3. For pairs of fire doors where no metal meeting edges are desired, specify "No Metal Meeting Edges Accepted." Metal astragals or edge sets for pairs of fire doors to be formed, premachined and veneer wrapped with same species as the door face.
- C. VERTICAL EDGES (STILES)
1. Non-rated and 20-minute rated shall be veneer banded stiles [or] optional 2-ply solid lumber 7/16 prior to bevel.
 2. Compatible Edges to match face veneer. (STC doors may include veneer banding with structural composite lumber backers or innerplies).
 3. 20-minute rated pairs (No metal edges or astragal required)
 - a. Treated edges on meeting stiles veneer banded to match face veneer.
 - b. Smoke seals required by manufacturer to permit positive pressure "S" label per Category H.
 - c. Specify per project requirements. Choose One construction and One pressure option for items 4 and 5, as needed.
 4. Mineral Core
 - a. Mineral core door stiles to manufacturer's standard edge for improved screw holding.
 - b. Single opening edges to be manufactured as required to meet label service listing. Optional veneer banded edge to match face if required.
 - c. Pairs of Mineral core door stiles to be veneer banded to match face veneer over manufacturer's edge to meet label service listing. (Neutral Pressure)
 - d. As required by manufacturer to meet Positive Pressure Category A (concealed intumescent) or B (frame mounted intumescent). Optional veneer banded edge to match face if required.
- D. HORIZONTAL EDGES (RAILS)
1. Mill option structural composite lumber or hardwood lumber.
- E. ADHESIVES
1. Face Adhesive: Type 1
- F. INNER BLOCKING FOR MINERAL CORE FIRE DOORS
1. Supply innerblocking for all surface applied hardware where through bolts are not accepted.
- G. MACHINING
1. Factory fit and machine doors for frame and finish hardware in accordance with hardware and NFPA 80 requirements and dimensions. Do not machine for surface hardware. Apply appropriate fire labels.
 2. Modify or omit this listing to meet your project requirements. If applicable, choose One.
- H. DUTCH DOORS TYPE:
1. One side shelf
 2. Two side shelf
 3. 20-minute shelf
 4. No shelf
 5. Rabbeted meeting rails

2.04 ACCESSORIES

- A. LOUVERS
1. Wood louvers as detailed on the elevations.
 2. Louvers to be furnished by the door manufacturer.
 3. Metal Louvers: Specified in Section 10255.
- B. GLAZING STOPS
1. Non-Rated:
 - a. Wood, of the same species/compatible with door species
 - b. Metal Vision Frames

2. Fire-Rated:
 - a. Flush beads, veneer wrapped with same species as door facing
 - b. Metal Vision Frames
 3. Verify compatibility of glazing system with positive pressure requirements.
 4. Adjust top rail on full glass doors to accept hardware so that no hardware is visible in daylight opening. STC doors with light kits shall be factory glazed to maintain rating & warranty
- C. MEETING EDGES FOR PAIRS OF FIRE RATED DOORS
1. Metal edge and astragal or metal edges [or] no-metal meeting edges
 2. Manufacture doors whereby the opening will not require either an overlapping metal edge and astragal or metal meeting edges. (Special hardware requirements apply).
 3. For Neutral Pressure 20 minute doors only - treated stiles at meeting edge.
 4. Meet Positive Pressure requirements for Category A (concealed intumescent) or Category B (frame mounted intumescent) doors.
- D. APPLIED MOLDINGS
1. As selected from manufacturer's standard profiles and install as detailed.
 2. Applied moldings to be affixed to the door without the use of nails or staples. No visible fasteners are permitted (unless STC rated)

2.05 FACTORY FINISH

- A. Doors to be factory finished to meet or exceed WDMA I.S. 1-A-04 specifications for a TR-6 catalyzed polyurethane finish system or AWI section 1500 specifications for a UV curable polyester urethane finish system. Factory finish to be Eggers' Gardall - water based stain and UV curable polyester urethane finish system that complies with all applicable Federal and State regulations for Volatile Organic Compounds (VOC) and Hazardous Air Pollutants (HAP) emission limitations per the EPA Clean Air Act.
 1. Color shall be Eggers Gardall Color: 04 Nutmeg.
- B. Custom factory finish doors in accordance with approved sample.
- C. Submit approved sample for all factory finishing.
- D. Factory finished doors to be installed just prior to substantial completion.
- E. Opaque Finish (Paint) Meet AWI specifications for opaque conversion varnish and WDMA specifications for OP-4.

PART 3. EXECUTION

3.01 3.1 EXAMINATION

- A. Verify substrate opening conditions .
- B. Verify that opening sizes and tolerances are acceptable and ready to receive this work.
- C. Do not install doors in frame openings that are not plumb or are out of tolerance for size or alignment.
- D. Use three hinges for doors 7'-6" in height or less and one additional hinge for each incremental 30 inches of height over 7'-6"

3.02 INSTALLATION

- A. Install fire-rated and non-rated doors in accordance with NFPA 80, Manufacturers' instructions and to ITS-WH/UL requirements.
- B. Trim non-rated door width by cutting equally on both jamb edges.
- C. Trim door height by cutting bottom edges to a maximum 3/4 inch (19-mm).
- D. Trim fire door height at bottom edge only, in accordance with fire rating requirements. Allow a fitting clearance of 1/8" at each side and at top of door.

- E. Do not trim Positive Pressure rated doors for width.
- F. Pilot drill screw and bolt holes using templates provided by hardware manufacturer. Use threaded through bolts for half surface hinges. [or]
 - 1. Select pilot holes to be factory drilled
- G. Pilot holes to be factory drilled [or]
 - 1. Exercise caution when drilling pilot holes and installing hinges to ensure pilot holes are not over-drilled and screws are not over-torqued. Follow Manufacturer's installation instructions for Positive Pressure doors. Do not use self-drilling or combination wood/metal screws on wood doors.
- H. Coordinate installation of doors with installation of frames and hardware
- I. Coordinate installation of glass and glazing.
- J. Install door louvers and light kits plumb and level.
- K. Reseal or refinish any doors that required site alteration.

3.03 3.3 WARRANTY TOLERANCES

- A. Conform to WDMA standards and testing methods for warp, cup, bow and telegraphing.

3.04 3.4 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.

END OF SECTION

SECTION 08334**COILING COUNTER DOORS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Fire-rated coiling counter doors and operating hardware.
- B. Electric motor operation; wiring from electric circuit disconnect to operator to control station.

1.02 RELATED REQUIREMENTS

- A. Section 09260 - Gypsum Board Assemblies: Openings.
- B. Section 09900 - Paints and Coatings: Field paint finish.
- C. Section 13851 - Fire Alarm System: Fire alarm interconnection.

1.03 REFERENCE STANDARDS

- A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.
- B. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2006.
- D. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association; 2007.
- E. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.
- F. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's standard literature showing materials and details of construction and finish. Include data on electrical operation.
- C. Shop Drawings: Indicate rough and actual opening dimensions, anchorage methods, hardware locations, and installation details.
- D. Samples: Submit two slats, 4 inches long illustrating shape, color and finish texture.
- E. Manufacturer's Instructions: Indicate installation sequence and installation, adjustment, and alignment procedures.
- F. Operation and Maintenance Data: Indicate modes of operation, lubrication requirements and frequency, and periodic adjustments required.
- G. Project Record Documents: Include as-built electrical diagrams for electrical operation and connection to fire alarm system.

PART 2 PRODUCTS**2.01 COILING COUNTER DOORS**

- A. Coiling Counter Doors, Fire-Rated: Galvanized steel slat curtain.
 - 1. Mounting: Exterior face mounted.
 - 2. Fire Rating: 1 hour; comply with NFPA 80.
 - a. Provide product listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.
 - 3. Nominal Slat Size: 1-1/4 inches wide.

4. Slat Profile: Flat.
5. Finish: Factory baked enamel.
6. Color: As selected from manufacturer's standard colors.
7. Guides: Formed track; same material and finish unless otherwise indicated.
8. Hood: Manufacturer's standard; primed steel.
9. Fire Release Mechanism: Electric motor closed, actuated by fire alarm system.
10. Non-Fire Operation: Electric motor.

2.02 MATERIALS

- A. Curtain Construction: Interlocking, single thickness slats.
 1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
 2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
 3. Steel Slats: ASTM A 653/A 653M galvanized steel sheet, with minimum G90/Z275 coating; minimum thickness 22 gage, 0.03 inch.
- B. Guide Construction: Continuous, of profile to retain door in place, with mounting brackets of same metal.
- C. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
- D. Latching: Inside mounted, sliding deadbolt.
- E. Roller Shaft Counterbalance: Steel pipe and torsion steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.03 ELECTRIC OPERATION

- A. Electrically Operated Doors: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Electric Operators:
 1. Mounting: Side mounted.
 2. Motor Enclosure: NEMA MG 1.
 3. Motor Rating: As recommended by manufacturer; continuous duty.
 4. Motor Voltage: 24 volt, single phase, 60 Hz.
 5. Opening Speed: 6 inches per second.
 6. Manual override in case of power failure.
- C. Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.
 1. 24 volt circuit.
 2. Surface mounted.
- D. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. In addition, install fire-rated doors in accordance with NFPA 80.

- C. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- D. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- E. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- F. Coordinate installation of electrical service with Section 16155.
- G. Complete wiring from disconnect to unit components.
- H. Complete wiring from fire alarm system .

3.03 TOLERANCES

- A. Maintain dimensional tolerances and alignment with adjacent work.
- B. Maximum Variation From Plumb: 1/16 inch.
- C. Maximum Variation From Level: 1/16 inch.
- D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING

- A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

- A. Clean installed components.
- B. Remove labels and visible markings.

END OF SECTION

SECTION 08410**METAL-FRAMED STOREFRONTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors and frames.
- C. Weatherstripping.

1.02 RELATED REQUIREMENTS

- A. Section 07900 - Joint Sealers: Perimeter sealant and back-up materials.
- B. Section 08710 - Door Hardware: Hardware items other than specified in this section.
- C. Section 08800 - Glazing: Glass and glazing accessories.
- D. Section 08910 - Metal-Framed Curtain Wall.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
- D. Design Data: Provide framing member structural and physical characteristics, engineering calculations, dimensional limitations.
- E. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- F. Samples: Submit two samples 4 inches in size illustrating finished aluminum surface, glass, infill panels, glazing materials.
- G. Report of field testing for water leakage.
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the State in which the Project is located.
- B. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.08 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Vistawall Architectural Products; Product Reliance Curtain Wall: www.vistawall.com..
- B. Other Acceptable Manufacturers:
 - 1. Kawneer North America: www.kawneer.com.
 - 2. United States Aluminum Corp: www.usalum.com.
 - 3. Traco; Product TR-7800. www.traco.com
 - 4. Substitutions: See Section 01600 - Product Requirements.

2.02 COMPONENTS

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Finish: High performance organic coating.
 - 2. Color: As selected from manufacturer's standards.
- B. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 - 1. Glazing stops: Flush.
 - 2. Cross-Section: As indicated on drawings.
- C. Doors: Vistawall PerformMax curtain wall door sub-frame.
 - 1. Finish: Same as storefront.

2.03 HARDWARE

- A. Door Hardware: As specified in Section 08710.
- B. Weatherstripping: pile, continuous and replaceable; provide on all exterior doors.
- C. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

2.04 FABRICATION

- A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
- C. Prepare components to receive anchor devices. Fabricate anchors.
- D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
- E. Arrange fasteners and attachments to conceal from view.
- F. Reinforce components internally for door hardware.
- G. Reinforce framing members for imposed loads.
- H. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.

1. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Coordinate attachment and seal of perimeter air and vapor barrier materials.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

3.04 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- C. Remove excess sealant by method acceptable to sealant manufacturer.

3.05 PROTECTION

- A. Protect installed products from damage during subsequent construction.

END OF SECTION

SECTION 08520**ALUMINUM WINDOWS****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Aluminum Windows
 - a. Type:
 - 1) Project Out
 - 2) Fixed
 - b. Category: Standard Commercial
 - c. Designation: P-C60 & C-C60.
 - 2. Window Components:
 - a. Hardware.
 - b. Sealants.
 - c. Glazing.
 - d. Weather-stripping.
 - e. Screens.
- B. RELATED SECTIONS
 - 1. Section 01340 - Shop Drawings, Product Data, and Samples.
 - 2. Section 07900 - Joint Sealers.
 - 3. Section 08800 - Glass and Glazing.

1.02 TESTING AND PERFORMANCE REQUIREMENTS

- A. Site Design, Structural Performance:
 - 1. The base design pressure for the project shall be in accordance with the governing local code. All structural components including meeting rails and mullions shall meet or exceed this performance level.
 - a. The base design pressure shall be increased an additional 10 percent within 10 feet from all building corners.
- B. Test Units: Units shall be glazed, completely assembled, constructed and tested with ventilators closed and locked in accordance with Drawings and Specifications and North American Fenestration Standard 101/I.S.2/NAFS-02 C60.
 - 1. Air, Water, and Structural Tests: Unit sizes shall be not less than:
 - a. PROJECTED: Ventilators 5'-0" X 3'-0" project out.
 - b. CASEMENTS: Ventilators 3'-0" X 5'-0" swing out.
- C. Test Procedures and Performance:
 - 1. Test sequence is optional except that air infiltration test shall precede water resistance test. Concentrated load tests may be performed on separate ventilators of identical size and design as used for air, water and uniform load tests.
 - 2. Air Infiltration Test:
 - a. Test unit in accordance with ASTM E 283 at 6.24 PSF static air pressure difference.
 - b. Air infiltration should not exceed:
 - 1) 0.10 CFM/LF...
 - 3. Water Resistance Test: There shall be no water leakage when tested in accordance with ASTM E 331 at 15 PSF static air pressure difference.
 - 4. Uniform Load Deflection Test: No member shall deflect more than 1/175 of its span when tested in accordance with ASTM E 330 at static air pressure of 60 PSF with high pressure applied first on one side of unit and then on the other side.
 - 5. Uniform Load Structural Test:
 - a. Test unit in accordance with ASTM E 330 at static air pressure difference of 90 PSF with high pressure applied first on one side of the unit and then on the other side.

- b. At conclusion of test there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms, nor any other damage to window that would cause it to be inoperable. Permanent deformation of any frame or ventilator member shall not exceed 0.2% of its span.
6. Thermal Transmittance (U-Factor): When tested to AAMA Specification 1503, the thermal transmittance (U-factor) shall not be more than: 0.35 (low-e)* or 0.59(clear).
7. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the Condensation Resistance Factor shall not be less than 55 frame and 66 glass (low-e)* OR 51 frame and 54 glass (clear).
* Low-e insulating glass: low-e (e= 0.040 #2) - 1/2" argon filled gap with steel spacer - 1/4" clear glass. Low-e insulating glass (U-factor) = 0.25.
8. Forced Entry Resistance: Windows shall conform to ASTM F 588 Type B Grade 10, or AAMA 1302.5.

1.03 REFERENCES (SEE AAMA WSG.1-95 and ANSI/AAMA/NWDA 101/I.S.2-97 FOR CURRENT APPLICABLE LISTINGS)

- A. AAMA (American Architectural Manufacturers Association):
- B. ANSI (American National Standards Institute):
- C. ASTM (American Society for Testing and Materials):
- D. CPSC (Consumer Product Safety Commission):
- E. GANA (Glass Association of North America):
- F. GSA (General Services Administration):

1.04 SUBMITTALS

- A. Provide submittals in a timely manner to meet required construction completion schedule and in accordance with Section 01340.
- B. Shop Drawings:
 1. Shall be complete and legible.
 2. Show components complete with dimensions, material and details of anchoring and fastening.
 3. Show finishes, sealants and other information indicating compliance with Specifications.
 4. Show recorded field measurements on final drawings.
- C. Samples:
 1. Components: Submit samples of anchors, fasteners, hardware, assembled corner sections and other materials and components if requested by architect.
 2. Finish: Submit color samples for approval by architect which represent the allowable range of finish established from production material specified.
- D. Test Reports: Submit test reports from independent laboratories verifying all performance requirements specified in Article - 1.02 TESTING AND PERFORMANCE REQUIREMENTS.
- E. Calculations: Submit test results and engineering calculations indicating adequacy of materials, anchors, fasteners, and other load bearing components to meet uniform load deflection and structural requirements.
- F. Warranties: Submit written copies including application procedures specified in article - 1.06 WARRANTIES.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect materials from damage before installation per instructions and in accordance with Sections 01610 and 01620.

1. Materials shall be packed, loaded, shipped, unloaded, stored and protected in manner that will avoid abuse, damage, and defacement in accordance with AAMA CW-10.
2. Remove wrappings and inter-leavings that are wet or which could become wet when unloading materials.
3. Store inside if possible in a clean, well-drained area free of dust and corrosive fumes.
4. Stack vertically or on edge so that water cannot accumulate on or within materials. Use non-staining wood or plastic shims between components to provide water drainage and air circulation.
5. Cover materials with tarpaulins or plastic hung on frames to provide air circulation and prevent contaminants from contacting aluminum.
6. Keep water away from stored assemblies.

1.06 WARRANTIES

- A. Window System:
1. Contractor shall warrant for two years the satisfactory performance of the window installation; which includes windows, hardware, glass, glazing, and anchorage as called for by the Specifications and approved shop drawings.
 2. Window manufacturer shall provide written 2-year warranty against defects in materials and workmanship in accordance with Section 01740. Longer term warranties available at extra cost.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Vistawall, Terrell, Texas. Drawings and Specifications are based on zsWINDOW Series ZS-2750.
1. Frames:
 - a. Wall Thickness: .093".
 - b. Depth W/ 1" Glass: 2 1/4"
 - c. Depth W/ 1/4" Glass: 2"
 2. Ventilators:
 - a. Wall Thickness: .094".
 - b. Depth W/ 1" Glass: 2 1/4".
 - c. Depth W/ 1/4" Glass: 2"
- B. Substitutions: Windows by other manufacturers with at least ten years of experience building similar products that meet or exceed specified design requirements may be considered as acceptable substitutions. Comply with substitution procedure specified in Division One -General Requirements. Submit following information not less than ten days before Bid Date with request for substitutions:
1. Test Reports specified in Article - 1.02 TESTING AND PERFORMANCE REQUIREMENTS.
 2. Samples specified in Article - 1.04 SUBMITTALS.
 3. If requested, other information required for evaluation of proposed substitutions.

2.02 MATERIALS

- A. Aluminum: Provide material of proper alloy and temper to meet specified requirements and compatibility with specified finishes.
1. Extrusions: Comply with ASTM B 221. Extrusion tolerances shall meet ANSI H35.2.
 2. Sheet: Comply with ASTM B 209.
- B. Hardware: Material shall be corrosion resistant and compatible with aluminum. Hardware must prove its strength and suitability by being installed on units that are tested in accordance with Specifications.
1. Fasteners: Provide nonmagnetic stainless steel screws, epoxy adhesives, or other material warranted by the manufacturer.
- C. Glass:
1. 1" I.G.
- D. Operating Hardware:

1. Window Type: Projected
 - a. Ventilator Hinges:
 - 1) Type: 4-Bar with Friction Device
 - 2) Material: 300 Series Stainless Steel with Nylon Friction Block Encased in Sliding Brass Shoe
 - b. Ventilator Locks, Handles or Operators:
 - 1) Type: Slim-line Cam
 - 2) Material: White Bronze with White Bronze Strike
- E. Anchoring: Material shall be of adequate strength required to meet the uniform load deflection and structural testing specified in Article - 1.02 TESTING AND PERFORMANCE REQUIREMENTS.
 1. Fasteners:
 - a. Concealed: Provide aluminum, cadmium plated steel or heavy cadmium plated carbon steel per GSA QQ-P-416C or ASTM A 165, zinc plated steel per ASTM B 633 or ASTM A 123, or 300 Series stainless steel.
 - b. Exposed: Provide 300 Series stainless steel.
 2. Anchors:
 - a. Concealed: Provide aluminum, zinc plated steel (after fabrication) per ASTM B 633 or ASTM A 123, stainless steel, or carbon steel painted (after fabrication) with zinc-chromate or other acceptable primers not containing lead.
 - b. Exposed: Provide aluminum or 300 Series stainless steel.
- F. Sealants: Color of exposed sealants shall be compatible with adjacent window materials.
 1. Non-working Joints: Comply with AAMA 803.3.
 2. Window Components: Sealing material shall be suitable for application specified and approved by window manufacturer.
 3. Perimeter: Comply with AAMA 808.3 and Section 07900. Provide in joint sizes recommended by GANA Sealant Manual.
- G. Glazing:
 1. Glazing Materials: Units shall be wet glazed using silicone cap beads
 - a. Setting Blocks/Edge Blocking: Provide in sizes and locations recommended by GANA Glazing Manual.
 - b. Back Bedding Glazing Tapes: Preformed elastomeric material used to bed glass or panels to surrounding aluminum shall meet AAMA 804.1 or AAMA 806.1.
 - c. Expanded Cellular Glazing Tapes: Preformed elastomeric material attached to used as a backer for silicone cap bead shall meet AAMA 810.1.
 - d. Toe or Heel Beads: Pumpable material used to control air and water penetration in glazing joints shall meet GSA TT-S-1657 and AAMA 802.3.
 - e. Cap Beads: Provide Type II Class A, pumpable silicone sealant applied within manufacturer's specified range of ambient temperatures and recommended cure time, in compliance with GSA TT-S-1543A and ASTM C 920.
- H. Weather-stripping: Dual Durometer Santoprene around perimeter of the exterior of all vents, and a foam-filled bulb vinyl perimeter of the interior face of all vents.
- I. Screens: Provide wicket screens with frames finished to match windows. Fiberglass mesh with pre-molded, PVC snap-lock wickets. [Wire mesh with pre-molded PVC snap-lock wickets.]

2.03 FABRICATION

- A. Frames: machined, mechanically fastened and sealed to form a watertight joint
- B. Ventilators: mitered, fastened with two screws per corner into screw splines
- C. Ventilator Limited Opening Device Attachment: Fasteners used to attach limit devices shall be tamper resistant or concealed to prevent removal.
 1. Mount each device to permit ventilator to open approximately 6" before automatically stopping.
 2. Operation beyond limiting point shall be by custodial access only.

- D. Component Forming: All aluminum components shall be formed, free of scratches and burrs, before application of finish.

2.04 FINISHES

- A. Finish: Provide coverage on all exposed areas of aluminum windows and components.
 - 1. Type: Architectural Class I two-step color anodizing.
 - 2. AAMA Specification: Comply with AAMA 611.
 - 3. Aluminum Association Designation: AA-M1-C22-A44.
 - 4. Color: Dark Bronze, Light Bronze, Medium Bronze, Black.

2.05 FINISHES

- A. Finish: Provide coverage on all exposed areas of aluminum windows and components.
 - 1. Type: Provide 70% polyvinylidene fluoride (Kynar 500) baked-on high performance organic coating
 - 2. AAMA Specification: Comply with AAMA 2605
 - 3. Aluminum Association Designation: AA-M10-C41-R1X
 - 4. Color: Custom Nonmetallic, Non-exotic Tone To Be Selected By Architect

PART 3 EXECUTION

3.01 INSPECTION

- A. When required, remove existing windows in accordance with Section 02070. Verify that openings are dimensionally within allowable tolerances, plumb, level, clean, provide a solid anchoring surface and are in accordance with approved shop drawings.
- B. Do not install windows until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install windows with skilled tradesman in accordance with approved shop drawings, Installation and Glazing Manuals, and Specifications.
- B. Aluminum that is not protected by an organic coating shall be insulated from direct contact with steel, masonry concrete, and non-compatible materials by bituminous paint, zinc chromate primer or other suitable insulating material.
- C. Install vapor retarder in accordance with 07190 and air barrier in accordance with 07195 between window perimeter and adjoining collateral materials and existing wall barriers to assure continuity.
- D. Plumb and align window faces in a single plane for each wall plane. Erect square and true. Anchor to maintain position when subjected to normal thermal and building movement, seismic forces and specified wind loads.
- E. Apply sealants at joints and intersections and at opening perimeters in accordance with approved shop drawings and Section 07900 to provide watertight installation. Wipe off excess material and leave exposed surfaces and joints clean and smooth.

3.03 FIELD QUALITY CONTROL

- A. Conduct on-site air and water infiltration tests with architect and window manufacturer's representative present. Architect will select units to be tested. If units fail to meet specified requirements, determine reasons for failure.
- B. Tested units not meeting specified requirements and units having similar deficiencies shall be corrected at no cost to owner.
- C. Cost for successful tests shall be paid by owner. Unsuccessful tests shall be paid by contractor.
- D. Testing shall be by agency acceptable to architect and window manufacturer and employed by contractor.

3.04 ADJUSTING AND CLEANING

- A. After installation and testing, windows and glazing shall be inspected, adjusted, and left clean and free of labels and dirt. Protect finished installation against damage.
- B. Final cleaning of anodized finish shall be in accordance with AAMA 609; painted finish shall be in accordance with AAMA 610, and Section 01710.

END OF SECTION

SECTION 08710**FINISH HARDWARE****PART 1 - GENERAL:****1.01 SUMMARY:**

- A. Section includes Finish Hardware
- B. Work under this section comprises of furnishing and installing hardware specified herein and noted on drawings for a complete and operational system, including all required mechanical and electrified hardware components, systems and controls. All doors that are fire rated shall be provided with fire rated hardware to comply with the local code requirements. The general contractor and hardware supplier shall coordinate cylinder types with all door manufacturers prior to submittal of finish hardware. There will be no additional change orders issued due to the general contractor or hardware supplier's failure to include any hardware item required by local code or required for functional and/or proper installation of hardware items due to failure to coordinate with other trades and/or related products.
- C. The General Contractor and Hardware Supplier shall notify the Architect in writing of any discrepancies five (5) days prior to bid date that could and/or would result in hardware being supplied that is none functional, hardware specified and/or hardware that has not been specified that will result in any code violations and any door that is not covered in this specification. Failure of the general contractor and hardware supplier to address any such issue shall be considered acceptance of the hardware specified and all discrepancies shall be corrected at the general contractor and hardware supplier's expense and considered a part of their base bid. Change orders shall not be issued if deemed by the Architect to fall under and/or be covered as a part of the supplier's base bid, due to failure to comply with this instruction notification.
- D. Items include but are not limited to the following:
 - 1. Hinges - Pivots
 - 2. Flush Bolts
 - 3. Exit Devices
 - 4. Locksets and Cylinders, Cores, Keys
 - 5. Push Plates - Pulls
 - 6. Coordinators
 - 7. Closers
 - 8. Kick, Mop and Protection Plates
 - 9. Stops, Wall Bumpers, Overhead Controls
 - 10. Electrified Hold Open Devices
 - 11. Thresholds, Gasketing and Door Bottoms
 - 12. Silencers
 - 13. Miscellaneous Trim and Accessories
 - 14. Mounting Plates, Brackets, Fasteners
 - 15. Electrified Hardware Items, Controls and Power Supplies
 - 16. Wiring diagrams
 - 17. Wire and Communication Cable (Furnish & Install)
 - 18. Installation & Testing of the Complete Access Control System
- E. Related Sections:
 - 1. Finish Carpentry - Division 6
 - 2. Metal Doors and Frames - Division 8
 - 3. Wood Doors - Division 8
 - 4. Aluminum Storefront - Division 8
 - 5. Acoustically Gasketed Doors - Division 8
 - 6. Electrical - Division 16

1.02 REFERENCES:

- A. Documents and Institutes that shall be used in estimating, detailing and installing the items specified.
 - 1. International Building Code - Current Edition
 - 2. ICC/ANSI A117.1 - Accessible and Usable Building and Facilities - Current Edition
 - 3. NFPA80 -Standards For Fire Doors and Fire Windows - Current Edition
 - 4. NFPA101 - Life Safety Code - Current Edition
 - 5. NFPA105 - Installation of Smoke-Control Door Assemblies - Current Edition.
 - 6. UL Labeled for Rated Doors.
 - 7. DHI - Door and Hardware Institute
 - 8. SDI- Steel Door Institute
 - 9. ANSI - American National Standards Institute
 - 10. BHMA - Builders Hardware Manufacturers Association
 - 11. Local Building Codes
 - 12. Leed - version 2.2

1.03 SUBMITTALS

- A. Comply with pertinent provisions of Section 01300.
- B. Finish Hardware Schedule to be in vertical format to include include:
 - 1. Heading #/Hardware Set
 - 2. Door #, Location, Hand, Degree of Opening, Door Size and Type, Frame Size and Type, Fire Rating
 - 3. Quantity, type, style, function, product, product number, size, fasteners, finish and manufacturer of each hardware item.
 - 4. Location of hardware set cross-referenced to indications on Drawings both on floor plans and in door and frame schedule.
 - 5. Keying schedule
 - 6. Title Sheet, Index, Abbreviations, Manufacturers List, Template List and Templates.
 - 7. Mounting locations for hardware.
 - 8. Explanation of abbreviations, symbols, and codes contained in schedule.
- C. Product Data: Product data shall be provided, in the form of a binder, manufacturer's technical product fact sheets for each item of hardware. Include whatever information may be necessary to show compliance with requirements, including instructions for installation and for maintenance of operating parts and finish.
- D. Wiring Diagrams: Riser/Elevation and Point to Point Wiring Diagrams shall be provided. Include whatever information may be necessary for coordination with other trades.
- E. Samples: Samples shall be provided as requested by owner or architect with Heading # and Door# marked on boxes. All samples shall be returned to the contractor and used on doors for which they were marked
- F. Templates: Templates of finish hardware items to be supplied are to be furnished to each fabricator of doors, frames and other work to be factory-prepared for the installation of hardware.
- G. Keying Schedule: A keying schedule shall be submitted using keyset symbols referenced in DHI manual "Keying Systems and Nomenclature." The keying schedule shall be indexed by door number, keyset, hardware heading number, cross keying instructions and special key stamping instructions.
- H. Operations and maintenance data: At the completion of the job, furnish to the owner two copies of an owner's operation and maintenance manual. The manual shall consist of a labeled hardcover three ring binder with the following technical information:
 - 1. Title page containing: Project name, address and phone numbers. Supplier's name, address and phone numbers.
 - 2. Table of Contents.
 - 3. Copy of final Finish Hardware Schedule and Keying Schedule
 - 4. Maintenance instruction for each item of hardware.
 - 5. Catalog pages for each product.

6. Installation Instructions and Parts List for all Locks, Exit Devices and Door Closers.

1.04 QUALITY ASSURANCES

- A. Substitutions: Request for substitutions shall not be accepted within this project. Architect, owner and Hardware Consultant have selected one (1) specified and two (2) equals listed hereinafter in the Hardware Schedule. By this selection process they have established three (3) equal products for competitive pricing, while insuring no unnecessary delays by a substitution process. If any specified product is listed as a "No Substitution" product, this product will be supplied as specified, with no alteration or request of substitution. The reason for this is to comply with the uniformity established at this project. Parts and supplies are inventoried for these particular products for ease and standardization of replacement.
- B. Supplier Qualifications: Supplier shall be recognized architectural finish hardware supplier, with warehousing facilities, who have been furnishing hardware in the project vicinity for a period of not less than 2 year and who is or employs a DHI Certified AHC or person with a minimum of 10 years of experience as a hardware supplier. This person shall be available at reasonable times during the course of the work for consultation about products hardware requirements, to the owner, architect and contractor.
- C. Installation Review: A Distributor Representative (AHC) shall perform a jobsite walk-through after completion of installation in order to review correct installation, adjustment, hardware applications and to verify that the correct hardware has been installed at the correct doors.
- D. Installer Qualifications: Installer for mechanical hardware shall have a minimum of 2 years of experience of installing architectural finish hardware and attend a pre-installation meeting with the manufacturer's representative of locks, exit devices and closers.
- E. Wiring and termination of electrified door hardware by security contractor shall be concurrent with the installation of these electrified components by the door hardware subcontractor.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Marking and packaging: Mark each item or package separately, with identification related to hardware set number, door number and keyset symbol.
- B. Delivery:
 1. Deliver individually packaged and properly marked finish hardware at the proper time and location to avoid any delays in construction or installation.
 2. At time of delivery, inventory hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
- C. Storage: Store hardware in enclosed, dry and locked area.

1.06 WARRANTY

- A. All finish hardware products shall be covered by a 1 year factory warranty from the date of substantial completion of the project.
- B. Supply warranty verification to the owner for products that provide factory warranties for periods longer than one year. Mechanical Door Closers shall carry a 10-year warranty.

1.07 MAINTENANCE:

- A. Maintenance Service
 1. None
- B. Extra Materials:
 1. Furnish 3 dozen extra screws and other fasteners of each size, type and finish used with the hardware items provided. These screws and fasteners are to be delivered to the hardware installer for use during installation. All extra screws and fasteners and all special installation tools furnished with the hardware shall be turned over to the owner at the completion of the job.

2. All installation tools provided by the manufacturers shall be turned over to the owner at the completion of the job.

PART 2 - PRODUCTS

2.01 2.01 MANUFACTURER

A. Manufacturer	Location	Abbreviation	Website
1. Bommer Industries, Inc.	Landrum, SC	BOM	www.bommer.com
2. Doromatic	Princeton, IL	COR	www.doromatic.com
3. Falcon	Security, CO	FAL	www.falconlock.com
4. Glynn Johnson	Indianapolis, IN	GLY	www.glynn-johnson.com
5. Hager Hinge Company	St Louis, MO	HAG	www.hagerhinge.com
6. Ives	Indianapolis, IN	IVE	www.iveshardware.com
7. LCN	Princeton, IL	LCN	www.lcnclosers.com
8. Monarch	Sheperdsville, KY	MON	www.monarchhardware.com
9. National Guard	Memphis, TN	NGP	www.ngpinc.com
10. Pemko	Ventura, CA	PEM	www.pemko.com
11. Rockwood	Rockwood, PA	ROC	www.rockwoodmfg.com
12. Schlage	Security, CO	SCH	www.schlage.com
13. Trimco/BBW/Quality	Los Angeles, CA	TRI	www.trimcobbw.com
14. Von Duprin	Indianapolis, IN	VON	www.vonduprin.com

2.02 MATERIALS

- A. Screws and Fasteners:
 1. Closers and exit devices provided for exterior doors shall be provided with thru-bolts.
 2. All finish hardware shall be installed to manufacturer's recommendations, using screws, attachments and installation tools provided with the hardware. No other screws or attachments are acceptable.
 3. All other products to meet door and frame conditions.
- B. Hinges:
 1. Template: Provide templated units only.
 2. Exterior: All exterior hinges shall be standard weight (.134 or .146 ga) five knuckle, ball bearing, full mortise type, stainless steel.
 3. Interior: All interior hinges shall be standard weight (.134 or .146 ga) five knuckle, ball bearing, full mortise type.
 4. Provide non-removable pins for all outswinging exterior and interior doors to receive locking hardware (whether indicated or not) at individual HW Sets in the schedule.
 5. Size: Provide 4 ½ x 4 ½ hinges on doors up to 3'0" in width. Provide 5 x 4 ½ hinges on door from 3'2" to 4'0" in width. Reference manufacturers catalog for all other sizes.
 6. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges for door leaf for doors 90" or less in height and one additional hinge for each 30" of additional height.
 7. The width of hinge shall be sufficient to clear all trim.
 8. Supply from the following list of manufacturers:
 - a. Ives
 - b. Hager
 - c. Bommer
- C. Continuous Hinges
 1. Hinges to be manufactured of 6063-T6 aluminum alloy with anodized finish.
 2. Door and frame leaves to be machined, anodized and assembled as a matched pair.
 3. Door and frame leaves to be anodized after all machining and drilling processes are complete.
 4. all hinge profiles shall be manufactured to template screw locations, with standard duty and heavy duty hole patterns identical as to number and placement of holes.

5. All hinge profiles to be manufactured to template bearing locations, with standard duty bearing configurations at 5 1/8" spacing with a minimum of 16 bearings; and heavy duty at 2 9/16" spacing with a minimum of 32 bearings.
 6. Hinge leaves to be extruded at a uniform 1/8" thickness from pivot point to outside edge of hinge leaf.
 7. Uncut hinges shall be non-handed and shall be a pinless assembly of three interlocking extrusions applied to the full height of the door and frame without mortising.
 8. Vertical door loads shall be carried on chemically lubricated thermoplastic thrust bearings.
 9. The door and frame leaves shall be continuously geared together for the entire hinge length and this relationship secured with a full-length cover channel so that the hinge will operate through a full 180 degrees.
 10. All rotating areas of the gear cap and geared leaves shall have a permanent lubricant which is factory applied along the full length of the hinge, and the lubricant shall last the life of the hinge with no additional maintenance required.
 11. Fasteners supplied shall be 410 stainless steel, bright hardened and plated.
 12. Supply from the following list of manufacturers:
 - a. Ives
 - b. Select
 - c. Zero
- D. Flush Bolts
1. Provide constant latching flush bolts that remains latched until the door is opened, then the top bolt can be manually released. The bottom bolt is automatic as shown in hardware sets
 2. UL listed for fire doors as required.
 3. Fits standard ANSI A115.4 Door and Frame preparation.
 4. Meets ANSI156.3, Type 27
 5. As codes and conditions permit, provide on the inactive door of pairs, extension flush bolts at top of doors. Provide all necessary strikes, shim and guides to insure proper installation.
 6. Supply from the following manufacturer:
 - a. Ives
 - b. Trimco
 - c. Rockwood
- E. Coordinator
1. Provide coordinator that is a bar type.
 2. UL listed for fire doors.
 3. Meets ANSI/BHMA A156.3, Type 21A
 4. Supply from the following manufacturer:
 - a. Ives
 - b. Trimco
 - c. Rockwood
- F. Cylindrical Locks/Latches
1. Provide cylindrical locksets that comply with ANSI A156.2, Series 4000, Grade 1; tested to exceed 3,000,000 cycles. Functions as listed in Hardware Sets.
 2. Provide cylindrical locksets that meet ANSI A117.1, Accessibility Code.
 3. Provide cylindrical locksets that meet UL A label; to have a minimum listing for single doors 4' x 8'
 4. Provide cylindrical locksets that comply with California Fire Safety Code; lever return to within 1/2" of the door where applicable.
 5. Lockset to have the ability to incorporate either a rigid or free-wheeling lever when in locked mode where shown in hardware sets.
 6. Chassis to be field-changeable to free-wheeling lever.
 7. Chassis to be one-piece, modular assembly.
 8. Chassis to be multi-functional; interchange of function assembly without disassembly of lockset.

9. Spindle to be deep-draw manufactured. Manufacturers utilizing stamped spindles are not acceptable.
 10. Spring Cage to have double compression springs. Manufacturers utilizing torsion springs are not acceptable.
 11. Spindle and Spring Cage (internal) to be one-piece integrated assembly.
 12. Levers to be bi-directional, independent assemblies.
 13. Levers to be free-wheeling when locked where shown in hardware sets.
 14. Levers are to be solid. Manufacturers utilizing fillers of any kind are not acceptable.
 15. Levers are to be plated to match BHMA finishes.
 16. Anti-rotation plate to be interlocking to lock chassis. Manufacturers utilizing anti-rotation plates with bit-tabs are not acceptable.
 17. Thru-bolts to be a minimum of 1/4" in diameter.
 18. Thru-bolts to secure anti-rotation plate without sheer line. Manufacturers utilizing fully threaded thru-bolts are not acceptable.
 19. Adjustment plate to be threaded for door thickness adjustment.
 20. Adjustment plate to adjust for doors from 1 5/8" thickness to 2 1/8" thickness.
 21. Adjustment plate to have visual chassis marking for doors 1 3/4" thick.
 22. Latchbolt to be steel with minimum 1/2" throw deadlatch on keyed and exterior functions; 3/4" throw anti-friction latchbolt on pairs of doors.
 23. Strike to be ANSI curved lip, 1 1/4" x 4 7/8", 16 gauge, with 1" deep box construction.
 24. All locksets and cylinders are to be provided by the same manufacturer, unless otherwise specified.
 25. Supply from the following list of manufacturers:
 - a. Schlage - ND
 - b. Falcon - T
 - c. Sargent - 11Line
- G. Exit Devices
1. All exit devices are to be architectural grade touch bar type. Mechanism case to be smooth.
 2. All exit devices to meet ANSI A156.3, 1994, Grade 1. All exit devices are UL listed for Accident Hazard or Fire Exit Hardware.
 3. All lever trim to match lock trim in design and finish.
 4. Dogging: All non-rated devices are to be provided with dogging. Cylinder dogging as shown in hardware sets.
 5. All devices are to be supplied and installed with thru-bolts.
 6. Mullion shall be removable. Keyed removable as shown in hardware sets.
 7. All push pads shall be metal, no plastic inserts allowed.
 8. Function and type as listed in hardware sets.
 9. All exit devices are to be provided by the same manufacturer, unless otherwise specified.
 10. Supply from the following list of manufacturers:
 - a. Von Duprin 33/99 Series (Von Duprin XP99 where indicated - no substitution)
 - b. Monarch 17/18 Series
 - c. Detex
- H. Pull Plates
1. Pull Plates to meet ANSI 156.6 for .050" thickness. Plate size to 4" x 16" with 1" round on pull plate.
 2. Supply from the following list of manufacturers
 - a. Ives
 - b. Trimco
 - c. Rockwood
- I. Push Plates
1. Push Plates to meet ANSI 156.6 for .050" thickness. Plate size to be 4" x 16".
 2. Supply from the following list of manufacturers
 - a. Ives

- b. Trimco
 - c. Rockwood
- J. Door Closers
1. Door closers shall meet the minimum requirements of the 1990 ADA act, in lieu of ANSI Standard A156.4 and ANSI, Grade 1.
 2. Door closers shall be furnished with full cover. Sized in accordance with the manufacturers recommendations for door size and condition.
 3. Door closers shall be furnished with backcheck, delayed action, hold-open and advanced backcheck as listed in the Hardware Schedule.
 4. Door closers shall be mounted out of the line of sight wherever possible (i.e., room side of corridor doors, etc.) with parallel arm mounting on out swinging doors. Mount closer top jamb or on brackets and/or drop plates, where special conditions call for it. All closer installation on wood doors shall include sex nut bolts.
 5. Supply from the following list of manufacturers
 - a. LCN 1460/4040 (4040XP where indicated - no substitution)
 - b. Doromatic SC70/SC80
 - c. Norton 7500/8500
- K. Door Protection Plates
1. Protective plates shall meet ANSI A156.6 requirements for .050 thickness.
 2. Kickplates shall be 10" by 2" less than door width on single door and 1" less than door width on pair of doors or as indicated in hardware sets. Beveled 3 edges.
 3. Armor plates shall be 34" by 2" less than door width or as indicated in hardware sets. Beveled 4 edges.
 4. Supply from the following list of manufacturers:
 - a. Ives
 - b. Rockwood
 - c. Trimco
- L. Door Stops and Holders:
1. Wall and Floor Stops: Supply wall stops where needed to protect doors or door hardware. When wall conditions do not permit use of wall stop provide floor stops with risers as needed to adjust for floor conditions.
 2. Overhead Stops: Where wall or floors stops are not applicable provide surface overhead stops.
 3. Supply from the following list of manufacturers:
 - a. Ives
 - b. Glynn Johnson
 - c. Trimco
- M. Silencers
1. Provide silencers on all doors without smoke seal or weatherstrip. 3 for single doors and 2 for pairs.
 2. Provide silencers as required for frame conditions
 3. Supply from the following list of manufacturer's
 - a. Ives
 - b. Rockwood
 - c. Trimco
- N. Thresholds/Weatherstripping
1. All thresholds shall conform to state and local handicap codes.
 2. Smoke seal shall be teardrop design bulb seal.
 3. Perimeter seal shall be vinyl.
 4. Drip strips shall protrude 2 1/2".
 5. Provide door sweeps with drip cap.
 6. Provide UL meeting stile gasketing for fire rated doors.
 7. Supply from the following list of manufacturer's

- a. National Guard
- b. Hager
- c. Pemko

2.03 FINISHES

CATEGORY	FINISH
A. Butts	
1. Interior Non Labeled	652
2. Interior Labeled	652
3. Interior Corrosive Area	630
4. Exterior	630
B. Continuous Hinges	ALUM
C. Flush Bolts/Dust Proof Strikes	626
D. Locks/Latches	626
E. Cylinders	626
F. Exit Devices	626/630
G. Door Closers	ALUM
H. Push Plates	630
I. Pull Plates	630
J. Protective Plates	630
K. Door Stops and Holders	626
L. Overhead Stops/ Holders	626
M. Weatherstrip and Threshold	ALUM

2.04 KEYING:

- A. General: Supplier will meet with owner to finalize keying requirements and establish a new Everest Restricted Grand Master Key System for the project with future expansion based on the owner's projected requirements.
- B. Keys: Provide nickel silver keys only. Furnish 3 change keys for each lock: 3 control keys: 12 construction masterkeys: 6 master keys for each master system and 6 grandmaster keys for each grandmaster key system. Deliver all keys to owners' representative.
- C. Provide brass construction core keying for this project with keys as required per Owner.
- D. Permanent cores shall be installed by the General Contractor when directed by Owner.

2.05 KEY CONTROL:

- A. Key Management: Provide a complete key storage and management system. Each key shall be fully cut, indexed, tagged and installed on cabinet hooks by the lock supplier and shipped with the locks. Key cabinet provided shall be wall-mounted type with capacity plus 50%.

2.06 KNOX BOX:

- A. Provide 3200-Series with swinging door and mortise kit "RMK" as manufactured by
 - 1. The Knox Company (See architectural drawings for location).

PART 3 - EXECUTION:**3.01 EXAMINATION:**

- A. Examine doors, frames and related items for conditions that would prevent the proper application of any finish hardware items. Do not proceed with installation until all defects are corrected.

3.02 INSTALLATION:

- A. Follow Door and Hardware Institute Publication for:
1. Recommended Location for Architectural Hardware for Standard Steel Doors and Frames
 2. Recommended Location for Builder's Hardware for Custom Steel Doors and Frames
 3. Recommended Locations for Architectural Hardware for Wood Flush Door
- B. Follow ANSI A117.1-1998 Accessible and Usable Building and Facilities
- C. Review mounting locations with Architect.
- D. Pre Installation meeting required with attendees to include Architect, Contractor, Carpenter, Supplier and Manufacturer's Representative for Exit Device, Locks and Closers before installation begins.

3.03 FIELD QUALITY CONTROL:

- A. After installation has been completed, obtain the services of a qualified hardware consultant to check for proper application of finish hardware, according to the finish hardware schedule and keying schedule. In addition, check all hardware for adjustments and proper operation.

3.04 ADJUST AND CLEAN:

- A. Adjust, clean and inspect all hardware, to ensure proper operation and function of every opening. Replace items, which cannot be adjusted to operate freely and smoothly as intended for the application made.

3.05 PROTECTION:

- A. The contractor shall use all means at his disposal to protect all finish hardware items from abuse, corrosion and other damage until the owner accepts the project as complete.

3.06 HARDWARE SCHEDULE

- A. HW SET: 01
DOOR NUMBER: 101, 102

EACH TO HAVE:

2	EA	CONTINUOUS HINGE	224HD-DOOR HEIGHT REQUIRED	628	IVE
1	EA	PANIC HARDWARE	CD33A-NL-OP	628	VON
1	EA	PANIC HARDWARE	CD33A-EO	628	VON
1	EA VON	MULLION	5654 (W-STRIP X 154)		628
2	EA	MORTISE CYLINDER	20-059 (CAM AS REQUIRED)	626	SCH
1	EA	RIM CYLINDER	20-079	626	SCH
3	EA	CONSTRUCTION CORE	23-030-ICX	626	SCH
3	EA	PERM CORE	23-030	626	SCH
2	EA	OFFSET DOOR PULL	8190-0-O	630	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH SNB	689	LCN

2	EA	MOUNTING PLATE	4040-18PA	689	LCN
1	EA	THRESHOLD	896S SIA X LENGTH AS REQUIRED	AL	NGP
2	EA	DOOR SWEEP	200NA-LENGTH AS REQUIRED	AL	NGP
1	SET	WEATHER STRIP	FURNISHED BY DOOR SUPPLIER BALANCE OF HARDWARE BY DOOR MFG		BYO BYO

B.

C. HW SET: 02

DOOR NUMBER: 103, 104, 201, 202

EACH TO HAVE:

6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	9927L-F-LBR 996L # 17 SNB	628	VON
1	EA	FIRE EXIT HARDWARE	9927L-F-LBR 996L-DT # 17 SNB	628	VON
1	EA	RIM CYLINDER	20-079	626	SCH
1	EA	CONSTRUCTION CORE	23-030-ICX	626	SCH
1	EA	PERM CORE	23-030	626	SCH
2	EA	SURFACE CLOSER	1461 EDA SNB	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
2	EA	MAGNETIC HOLD-OPEN	SEM 7850 24VDC (PROJECTION AS REQD)	AL	LCN
1	SET	SEALS	2525B-HEAD & JAMBS	BRN	NGP
1	SET	ASTRAGAL	9605A-HEIGHT AS REQ'D	AL	NGP

MAGNETIC HOLDERS TO RELEASE UPON ACTIVATION OF THE BUILDING FIRE ALARM SYSTEM

D. HW SET: 03

DOOR NUMBER: 105, 111, 203, 211, 214, 244

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	ND70TD SPA	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	1461 RW/PA SNB	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

E. HW SET: 04

DOOR NUMBER: 106, 107, 108, 109, 110, 112, 113, 114, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 141, 142, 144, 146, 148, 150, 152, 159, 161, 163, 165, 167, 204, 205, 206, 207, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 238, 239, 240, 242, 243, 245, 246,

248, 250, 251, 255, 256, 257, 258, 259, 261, 262

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	ND70TD SPA	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

F. HW SET: 05

DOOR NUMBER: 115

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY SET	ND40S SPA	626	SCH
1	EA	INDICATOR DEADBOLT	B571	626	SCH
1	EA	ROLLER BUMPER	RB471	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1	EA	COAT HOOK	572	626	IVE

G. HW SET: 06

DOOR NUMBER: 116, 187, 263

EACH TO HAVE:

6	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	FLUSH BOLT	FB458 (TOP)-LENGTH AS REQD	626	IVE
1	EA	FLUSH BOLT	FB458-12" (BOTTOM)	626	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	CLASSROOM LOCK	ND70TD SPA 14-042	626	SCH
1	EA	PERM CORE	23-030	626	SCH
2	EA	OVERHEAD STOP	450S SERIES X SNB	630	GLY
1	EA	ASTRAGAL	139SS X 5050	630	
		NGP			
2	EA	SILENCER	SR64	GRY	IVE

H. HW SET: 07

DOOR NUMBER: 117, 212

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
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1	EA	DEADBOLT	B663T	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303-8 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	1461 RW/PA SNB	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

I. HW SET: 07.1

DOOR NUMBER: 175, 176, 177, 178

EACH TO HAVE:

3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	DEADBOLT	B663T	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303-8 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	1461 RW/PA SNB	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	FLOOR HOLDER	FS41	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

J. HW SET: 07.2

DOOR NUMBER: 189, 190

EACH TO HAVE:

3	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	DEADBOLT	B663T	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303-8 4" X 16"	630	IVE
	EA	SURFACE CLOSER	1461 SHCUSH SNB	689	LCN
1	EA	ARMOR PLATE	8400 34" X 2" LDW	630	IVE
1	EA	FLOOR HOLDER	FS41	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

K. HW SET: 08

DOOR NUMBER: 118, 125, 127, 131, 133, 135, 137, 139, 147, 149, 151, 153, 160, 162, 164, 166, 168, 181, 193, 208, 209, 213, 264

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY SET	ND40S SPA	626	SCH
1	EA	INDICATOR DEADBOLT	B571	626	SCH
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1	EA	COAT HOOK	572	626	IVE

L. HW SET: 08.1

DOOR NUMBER: 121, 123, 129, 143, 145

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1	EA	COAT HOOK	572	626	IVE

M. HW SET: 09

DOOR NUMBER: 119, 156, 179, 180, 195, 229, 241, 247, 249, 252, 260,

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

N. HW SET: 10

DOOR NUMBER: 157, 253

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	1461 RW/PA SNB	689	LCN

1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
1	SET	SEALS	2525B-HEAD & JAMBS	BRN	NGP

O. HW SET: 11

DOOR NUMBER: 158

EACH TO HAVE:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	FIRE EXIT HARDWARE	99NL-F SNB	628	VON
1	EA	RIM CYLINDER	20-079	626	SCH
1	EA	CONSTRUCTION CORE	23-030-ICX	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	1461 SCUSH SNB	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	SET	SEALS	2525B-HEAD & JAMBS	BRN	NGP
1	EA	DOOR BOTTOM	420NA-LENGTH AS REQUIRED	AL	NGP

P. HW SET: 12

DOOR NUMBER: 169, 170, 232, 233

EACH TO HAVE:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	PANIC HARDWARE	99L 996L # 17 SNB	628	VON
1	EA	RIM CYLINDER	20-079	626	SCH
1	EA	CONSTRUCTION CORE	23-030-ICX	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	1461 EDA SNB	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

Q. HW SET: 13

DOOR NUMBER: 154, 186, 230, 254

EACH TO HAVE:

6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	9927L-F-LBR 996L # 17 SNB	628	VON
1	EA	FIRE EXIT HARDWARE	9927L-F-LBR 996L-DT # 17 SNB	628	VON

1	EA	RIM CYLINDER	20-079		626	SCH
1	EA	CONSTRUCTION CORE	23-030-ICX		626	SCH
1	EA	PERM CORE	23-030		626	SCH
2	EA	SURFACE CLOSER	4041 RW/PA SNB		689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW		630	IVE
2	EA	SECURITY FLOOR STOP	FS18S		BLK	IVE
1	SET	SEALS	2525B-HEAD & JAMBS		BRN	NGP
2	EA	DOOR BOTTOM	420NA-LENGTH AS REQUIRED	AL	NGP	
1	SET	ASTRAGAL	9605A-HEIGHT AS REQ'D		AL	NGP

R.

S. HW SET: 14

DOOR NUMBER: 155, 185, 188

EACH TO HAVE:

2	EA	CONTINUOUS HINGE	224HD-DOOR HEIGHT REQUIRED		628	IVE
1	EA	PANIC HARDWARE	XP99NL SNB		628	VON
1	EA	PANIC HARDWARE	XP99DT X 990DT SNB		628	
		VON				
1	EA	MULLION	KR4954		689	VON
1	EA	MULLION STORAGE KIT	MT54		689	VON
1	EA	MORTISE CYLINDER	20-059 (CAM AS REQUIRED)		626	SCH
1	EA	RIM CYLINDER	20-079		626	SCH
2	EA	CONSTRUCTION CORE	23-030-ICX		626	SCH
2	EA	PERM CORE	23-030		626	SCH
2	EA	SURFACE CLOSER	4040XP SCUSH SNB		689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW		630	IVE
2	EA	SECURITY FLOOR STOP	FS18S		BLK	IVE
1	EA	THRESHOLD	896S SIA X LENGTH AS REQUIRED	AL	NGP	
1	SET	SEALS	162S-HEAD & JAMBS		AL	NGP
2	EA	DOOR SWEEP	200NA-LENGTH AS REQUIRED		AL	NGP
1	EA	MULLION SEAL	5100N-HEIGHT AS REQD		BLK	NGP
1	EA	DRIP CAP	16A-FRAME WIDTH PLUS 4"		AL	NGP

T. HW SET: 14.1

DOOR NUMBER: 182

EACH TO HAVE:

2	EA	CONTINUOUS HINGE	224HD-DOOR HEIGHT REQUIRED		628	IVE
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1	EA	PANIC HARDWARE	XP99NL SNB	628	VON
1	EA VON	PANIC HARDWARE	XP99DT X 990DT SNB	628	
1	EA	MULLION	KR4954	689	VON
1	EA	MULLION STORAGE KIT	MT54	689	VON
1	EA	MORTISE CYLINDER	20-059 (CAM AS REQUIRED)	626	SCH
1	EA	RIM CYLINDER	20-079	626	SCH
2	EA	CONSTRUCTION CORE	23-030-ICX	626	SCH
2	EA	PERM CORE	23-030	626	SCH
2	EA	SURFACE CLOSER	4040XP SHCUSH SNB	689	LCN
2	EA	ARMOR PLATE	8400 34" X 2" LDW	630	IVE
2	EA	SECURITY FLOOR STOP	FS18S	BLK	IVE
1	EA	THRESHOLD	896S SIA X LENGTH AS REQUIRED	AL	NGP
1	SET	SEALS	162S-HEAD & JAMBS	AL	NGP
2	EA	DOOR SWEEP	200NA-LENGTH AS REQUIRED	AL	NGP
1	EA	MULLION SEAL	5100N-HEIGHT AS REQD	BLK	NGP
1	EA	DRIP CAP	16A-FRAME WIDTH PLUS 4"	AL	NGP

U. HW SET: 15

DOOR NUMBER: 173, 174, 234, 235

EACH TO HAVE:

6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	PANIC HARDWARE	9927L-LBR 996L # 17 SNB	628	VON
1	EA	PANIC HARDWARE	9927L-LBR 996L-DT # 17 SNB	628	VON
1	EA	RIM CYLINDER	20-079	626	SCH
1	EA	CONSTRUCTION CORE	23-030-ICX	626	SCH
1	EA	PERM CORE	23-030	626	SCH
2	EA	SURFACE CLOSER	1461 EDA SNB	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
2	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
1	SET	ASTRAGAL	9605A-HEIGHT AS REQ'D	AL	NGP
2	EA	SILENCER	SR64	GRY	IVE

V. HW SET: 16

DOOR NUMBER: 191, 192

EACH TO HAVE:

3	EA	HINGE	5BB1HW 5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	ND80TD SPA	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	OVERHEAD STOP	450S SERIES X SNB	630	GLY
1	EA	FLOOR/WALL	FS13/WS407CCV (AS REQD)	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
PROVIDE OH STOP AT DOOR # 191					

W. HW SET: 17

DOOR NUMBER: 183, 184, 194

EACH TO HAVE:

3	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	STOREROOM LOCK	ND80TD SPA 14-042	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA SNB	689	LCN
1	EA	SECURITY FLOOR STOP	FS18S	BLK	IVE
1	EA	THRESHOLD	425 SIA X LENGTH AS REQUIRED	AL	NGP
1	SET	SEALS	162S-HEAD & JAMBS	AL	NGP
1	EA	DOOR SWEEP	200NA-LENGTH AS REQUIRED	AL	NGP
1	EA	DRIP CAP	16A-FRAME WIDTH PLUS 4"	AL	NGP

X. HW SET: 17.1

DOOR NUMBER: 303, 304

EACH TO HAVE:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	ND80TD SPA 14-042	626	SCH
1	EA	PERM CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP EDA SNB	689	LCN
1	EA	SECURITY FLOOR STOP	FS18S	BLK	IVE
1	EA	THRESHOLD	896S SIA X LENGTH AS REQUIRED	AL	NGP
1	SET	SEALS	162S-HEAD & JAMBS	AL	NGP
1	EA	DOOR SWEEP	200NA-LENGTH AS REQUIRED	AL	NGP
1	EA	DRIP CAP	16A-FRAME WIDTH PLUS 4"	AL	NGP

DOOR # 304 IS 20M RATED

Y. HW SET: 18

DOOR NUMBER: 210

EACH TO HAVE:

6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	SET	AUTO FLUSH BOLT	FB41P (WD)	630	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	CLASSROOM LOCK	ND70TD SPA 14-042	626	SCH
1	EA	PERM CORE	23-030	626	SCH
2	EA	SURFACE CLOSER	1461 SHCUSH SNB	689	LCN
1	EA	COORDINATOR	COR X FL X CLOSER BRKTS	628	IVE
2	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	ASTRAGAL	139SS X 5050		630
		NGP			
2	EA	SILENCER	SR64	GRY	IVE

Z. HW SET: 19

DOOR NUMBER: 301, 302

EACH TO HAVE:

6	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	FIRE EXIT HARDWARE	99L-F 996L # 17 SNB	628	VON
1	EA	FIRE EXIT HARDWARE	99L-F 996L-DT # 17 SNB	628	VON
1	EA	MULLION	KR9954	689	VON
1	EA	MULLION STORAGE KIT	MT54	689	VON
1	EA	MORTISE CYLINDER	20-059 (CAM AS REQUIRED)	626	SCH
1	EA	RIM CYLINDER	20-079	626	SCH
2	EA	CONSTRUCTION CORE	23-030-ICX	626	SCH
2	EA	PERM CORE	23-030	626	SCH
2	EA	SURFACE CLOSER	4040XP RW/PA SNB	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
2	EA	SECURITY FLOOR STOP	FS18S	BLK	IVE
1	EA	THRESHOLD	425 SIA X LENGTH AS REQUIRED	AL	NGP
1	SET	SEALS	162S-HEAD & JAMBS	AL	NGP
2	EA	DOOR SWEEP	200NA-LENGTH AS REQUIRED	AL	NGP
1	EA	MULLION SEAL	5100N-HEIGHT AS REQD	BLK	NGP
1	EA	DRIP CAP	16A-FRAME WIDTH PLUS 4"	AL	NGP

END OF SECTION

SECTION 08911**GLAZED ALUMINUM CURTAIN WALL****PART 1 - GENERAL****1.01 SUMMARY**

- A. Related Documents: Conditions of the Contract, Division 1 - General Requirements, and Drawings apply to Work of this Section.
- B. Section Includes:
 - 1. Aluminum curtain wall systems, complete with reinforcing, shims, anchors, and attachment devices.
 - 2. Accessories necessary to complete Work.
- C. Products Furnished But Not Installed Under this Section: Inserts and anchoring devices that are to be built into structure.
- D. Related Sections:
 - 1. Section 05500 - Metal Fabrications.
 - 2. Section 07211 - Batt and Blanket Insulation.
 - 3. Section 07900 - Joint Sealers.
 - 4. Section 0841X - Aluminum Entrances and Storefronts.
 - 5. Section 08520 - Aluminum Windows.
 - 6. Section 08710 - Door Hardware.
 - 7. Section 08810 - Glass and Glazing.

1.02 REFERENCES

- A. Aluminum Association (AA):
 - 1. DAF-45 Designation System for Aluminum Finishes.
- B. American Architectural Manufacturers Association (AAMA):
 - 1. Aluminum Curtain Wall Design Guide Manual.
 - 2. 501.2 Field Check of Metal Curtain Walls for Water Leakage.
 - 3. 2605 Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
 - 4. 606.1 Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
 - 5. 607.1 Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum
 - 6. 608.1 Specification and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum.
 - 7. 701.2 Specifications for Pile Weatherstripping.
 - 8. Manual #10 Care and Handling of Architectural Aluminum From Shop to Site.
- C. American National Standards Institute (ANSI):
 - 1. Z97.1 Specifications and Methods of Test for Safety Glazing Material Used in Buildings.
- D. American Society for Testing and Materials (ASTM):
 - 1. A36 Structural Steel.
 - 2. A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. A525 General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
 - 4. A526 Sheet Steel, Zinc Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
 - 5. B209 Aluminum and Aluminum-Alloy Sheet and Plate.
 - 6. B221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
 - 7. B308 Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded.
 - 8. C716 Installing Lock-Strip Gaskets and Infill Glazing Materials.

9. C920 Elastomeric Joint Sealants.
 10. E283 Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.
 11. E330 Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 12. E331 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 13. E773 Test Method for Seal Durability of Sealed Insulating Glass Units.
 14. E774 Sealed Insulating Glass Units.
- E. Consumer Product Safety Commission (CPSC):
1. 16 CFR 1201 Safety Standard for Architectural Glazing Materials.
- F. Federal Specifications (FS):
1. TT-P-645A Primer, Paint, Zinc Chromate, Alkyd Type.
- G. Glass Association of North America (GANA):
1. Glazing Manual.
- H. Steel Structures Painting Council (SSPC):
1. SP2 Hand Tool Cleaning.
 2. SP3 Power Tool Cleaning.
 3. Paint 12 - Cold-Applied Asphalt Mastic (Extra Thick Film).

1.03 SYSTEM REQUIREMENTS

- A. General Standard: In addition to requirements shown or specified, comply with applicable provisions of Aluminum Curtain Wall Design Guide Manual for design, materials, fabrication and installation of component parts.
- B. Design Requirements:
1. Metal stick framed systems with interior and exterior exposed metal framing.
 2. Operable vent with sight line concealed from the exterior. Perimeter members to be integral with window wall framing.]
 3. System manufacturer shall provide low profile entrance frames as an integral part of the curtain wall system.]
 4. System manufacturer shall provide curtainwall systems, including necessary modifications to meet specified requirements and maintaining visual design concepts.
 5. Fabricate glazing systems for exterior glazing at vision areas and exterior glazing at spandrel areas.
 6. Perimeter conditions shall allow for installation tolerances, expansion and contraction of adjacent materials, and sealant manufacturer's recommended joint design.
 7. Drawings are diagrammatic and do not purport to identify nor solve problems of thermal or structural movement, glazing, anchorage or moisture disposal.
 8. Requirements shown by details are intended to establish basic dimension of unit, sight lines and profiles of members.
 9. Do not assume glass, sealants, and interior finishes contribute to framing member strength, stiffness, or lateral stability.
 10. Attachment considerations are to take into account site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening or fracturing connection between units and building structure or between units themselves.
 11. Anchors, fasteners and braces shall be structurally stressed not more than 50% of allowable stress when maximum loads are applied.
 12. Allow for expansion and contraction due to structural movement without detriment to appearance or performance.
 13. System shall drain to exterior face of wall, water entering joints and condensation occurring within system by drain holes and gutters of adequate size to evacuate water without infiltration to interior or the top of lower lites of glass.
 14. Provide concealed fastening.

15. Metal faces are required to be visually flat under all lighting conditions, subject to acceptance of Architect.
 16. Use dense EPDM isolators to maintain adequate compression on glazing material.
 17. Provide uniform color and profile appearance at components exposed to view.
 18. Provide interior dense EPDM [closed cell EPDM sponge] gasket with sealed corners, with maximum 30% compression when glazed, to create a water and air seal. Provide exterior dense EPDM wedge gasket at the verticals and exterior EPDM gasket at the horizontals, with a maximum 30% compression when glazed, to create a water & air seal.
 19. Provide pre-punched pressure plates to ensure correct quantity and spacing of fasteners.
 20. Stresses placed on structural silicone sealants shall be kept within sealant manufacturer's recommended maximum.]
 21. Not Permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system.
- C. Performance Requirements:
1. Air infiltration: Air leakage shall not exceed 0.06 cfm per square foot of surface area when tested in accordance with ASTM E283 at differential static pressure of 6.24 psf.
 2. Water Resistance (static): No uncontrolled leakage when tested in accordance with ASTM E331 at test pressure of 15.0 psf as defined in AAMA 501.
 3. Water Resistance (dynamic): No uncontrolled leakage when tested in accordance with ASTM E331 at test pressure of 15.0 psf as defined in AAMA 501.
 4. Uniform Load: A static air design load of 40 psf shall be applied in a positive and negative direction in accordance with ASTM E 330. At structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.
- D. Structural Requirements:
1. Wind loading:
 - a. Basic zones:
 - b. Corner zones:
 - c. Parapet zones:
 2. Deflection under uniform loading: When tested in accordance with ASTM E330 at design pressure, maximum deflection of exterior member shall not exceed $L/175$ for spans up to 13'-6" or $L/240 + 1/4"$ for spans greater than 13'-6".
 3. Parallel to wall and corner mullion deflections: 75% of glass edge bite or 3/8 inch, whichever is less.
 4. Compression flanges of flexural members may be assumed to receive effective lateral bracing only from:
 - a. Anchors to building structure and
 - b. Horizontal glazing rails or interior trim, which are in actual contact with compression flange.
 5. Do not regard points of contra-flexure as lateral braces or as end points of un-braced length; un-braced length is actual distance between effective lateral braces as defined above.
 6. Where framing member reaction is resisted by continuous element, maximum assumed effective length of the resisting element is 4 times bearing length, but not more than 12 inches.
- E. Thermal Requirements: Framing systems shall accommodate expansion and contraction movement due to surface temperature differential of 180°F without causing buckling, stress on glass, failure of joint seals, excessive stress on structural elements, reduction of performance or other detrimental effects.
- F. Thermal Transmittance (U-factor): When tested to AAMA Specification 1503, the thermal transmittance (U-Factor) shall not be more than .63 (with clear glass).
- G. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than 66 (for the frame).

- H. Seismic: When tested to AAMA 501.4, system must meet design displacement of 0.010 x the story height and ultimate displacement of 1.5 x the design displacement, 0.015 x the story height, and 0.025 x the story height.
- I. Sound Transmission: When tested to ASTM E90, the Sound Transmission Class (STC) shall not be less than 33 based upon 1" insulating glass (1/4", 1/2" AS, 1/4"); OR, not less than 37 based upon 1" insulating glass (1/4" Lam, 1/2" AS, 1/4" Lam).
- J. Laboratory Testing: Refer to Section 01411 for requirements.]
- K. Interface:
 - 1. Furnish inserts and anchoring devices, which need to be preset and built into structure to appropriate trade.
 - 2. Supply on timely basis to avoid delay in Work.
 - 3. Instruct other trades of proper location and position.
 - 4. Furnish setting drawings, diagrams, templates and installation instructions.

1.04 SUBMITTALS

- A. General: Submit in accordance with Section 01300.
- B. Product Data:
 - 1. Submit manufacturer's descriptive literature for each manufactured products.
 - 2. Include information for factory finishes, accessories and other required components.
 - 3. Include color charts for finish indicating manufacturer's standard colors available for selection.]
- C. Shop Drawings:
 - 1. Submit drawings indicating elevations, detailed design, dimensions, member profiles, joint locations, arrangement of units, member connections, and thickness of various components.
 - 2. Show following items:
 - a. Details of special shapes.
 - b. Reinforcing.
 - c. Drainage details and flow diagrams.
 - d. Anchorage system.
 - e. Interfacing with building construction.
 - f. Provisions for system expansion and contraction
 - g. Thermal breaks.]
 - h. Indicate glazing details, methods, [locations of various types and thickness of glass] [, emergency breakout locations,] and internal sealant requirements.
 - i. Clearly indicate locations of exposed fasteners and joints for Architect's acceptance.
 - j. Clearly show where and how manufacturer's system deviates from Contract Drawings and these Specifications.
- D. Mock-up Drawings: Submit drawings for mock-ups; refer to Section 01430 for mock-up requirements.]
- E. Samples:
 - 1. Submit manufactures samples indicating quality of finish in required colors.
 - 2. Where normal texture or color variations are expected, include additional samples illustrating range of variation.
 - 3. Submit samples of structural glazing gaskets, 12 inch lengths.]
 - 4. Submit samples of sealants for color selection.]
- F. Test Reports: Submit certified copies of previous tests reports by independent laboratory substantiating performance of system. Include other supportive data as necessary.]
- G. Certificates:
 - 1. Submit manufacturer's certification stating that installed system is in compliance with specified requirements.
- H. Manufacturer's Instructions: Submit manufacturer's printed installation instructions. [Include detailed

instructions describing each step of re-glazing procedures.]

- I. Warranty: Submit specified warranties.

1.05 QUALITY ASSURANCE

- A. Single Source Responsibility:
 1. Provide curtainwall systems that are products of a single manufacturer.
- B. Engineer Qualifications: Professional Structural Engineer registered in State where Project is located.
- C. Installer Qualifications: Certified in writing by system manufacturer as qualified for specified systems.

1.06 PRE-INSTALLATION CONFERENCE

- A. Conduct pre-installation conference in accordance with Section 01200.
- B. Conference Purpose and Agenda:
 1. Arrange with Architect and representatives of window and sealant manufacturer to visit Project site [factory] before beginning glazing operations to analyze site conditions, and inspect surfaces and joints to be sealed in order that recommendations may be made should adverse conditions exist.
 2. Discuss following items:
 - a. Weather conditions under which work will be done.
 - b. Anticipated frequency and extent of joint movement.
 - c. Joint design.
 - d. Glazing procedures.]

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Section 01600.
- B. Protect finished surfaces to prevent damage.
- C. Do not use adhesive papers or sprayed coatings, which become firmly bonded when exposed to sun.
- D. Do not leave coating residue on surfaces.
- E. Deliver glass units with manufacturer's labels intact on interior side of glass. Ensure labels indicate glass thickness, unit location, glass strength and orientation of units in vertical position.]
- F. Protect glass edges and corners to prevent chipping, cracking, and other similar damages.]

1.08 PROJECT CONDITIONS

- A. Ensure ambient and surface temperatures and joint conditions are suitable for installation of materials.

1.09 WARRANTY

- A. Provide warranties in accordance with Section 01700.
- B. Provide written warranty in form acceptable to Owner jointly signed by manufacturer, installer and Contractor warranting work to be watertight, free from defective materials, defective workmanship, glass breakage due to defective design, and agreeing to replace components which fail within 1 year from date of Substantial Completion.
- C. Warranty shall cover following:
 1. Complete watertight and airtight system installation within specified tolerances.
 2. Glass and glazing gaskets will not break or "pop" from frames due to design wind, expansion or contraction movement or structural loading.
 3. Glazing sealants and gaskets will remain free from abnormal deterioration or dislocation due to sunlight, weather or oxidation.

- D. Provide written warranty stating organic coating finish will be free from fading more than 10%, chalking, yellowing, peeling, cracking, pitting, corroding or non-uniformity of color, or gloss deterioration beyond manufacturer's descriptive standards for 5 years from date of Substantial Completion and agreeing to promptly correct defects.

PART 2 - PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS

- A. Subject to compliance with requirements indicated, provide products by one of the following:
1. Vistawall Architectural Products, Terrell, TX.
 2. Substitutions: Submit under provisions of Section 01630, a minimum of 10 days prior to bid date.
 3. Vistawall curtainwall systems included in this section are as follows:
 - a. RELIANCE WALL
 - 1) 1" Glazing: 2-1/2" x 6", or 7-1/4" mullion profiles; pressure glazed, front set, exterior glazed, stick wall system.

2.02 FRAMING MATERIALS AND ACCESSORIES

- A. Aluminum:
1. ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 5005-H16 for sheets; or other alloys and temper recommended by manufacturer appropriate for specified finish.
- B. Internal Reinforcing:
1. ASTM A36 for carbon steel; or ASTM B308 for structural aluminum.
 2. Shapes and sizes to suit installation.
 3. Shop coat steel components after fabrication with alkyd type zinc chromate primer complying with FS TT-P-645.
- C. Inserts and Anchorage Devices:
1. Manufacturer's standard formed or fabricated assemblies, steel or aluminum, of shapes, plates, bars or tubes.
 2. Hot-dip galvanize steel assemblies after fabrication, comply with ASTM A123, 2.0 ounce minimum coating.
 3. Shop coat steel assemblies after fabrication with alkyd type zinc chromate primer complying with FS TT-P-645.]
- D. Fasteners:
1. Non-magnetic stainless steel or cadmium plated steel coated with yellow or silver iridescence plating, compatible with materials being fastened.
 2. Series 300 stainless steel for exposed locations. Cadmium plated steel with 0.0005 inch plating thickness and color chromate coated for concealed locations.
 3. Provide nuts or washers of design having the means to prevent disengagement; deforming of fastener threads is not acceptable.
 4. Provide concealed fasteners wherever possible.
 5. For exposed locations, provide countersunk flathead fasteners with finish matching item fastened.
- E. Expansion Anchor Devices: Lead-shield or toothed-steel, drilled-in, expansion bolt anchors.
- F. Shims: Non-staining, non-ferrous, type as recommended by system manufacturer.
- G. Protective Coatings: Cold applied asphalt mastic complying with SSPC-Paint 12, compounded for 30 mil thickness for each coat; or alkyd type zinc chromate primer complying with FS TT-P-645.
- H. Glazing Gaskets:
1. Compression type design, exterior replaceable, extruded EPDM. Interior is a dense EPDM [closed cell EPDM sponge] gasket.
 2. Comply with ASTM C509 or C864.
 3. Profile and hardness as necessary to maintain uniform pressure for watertight seal.
 4. Manufacturer's standard black color.

- I. Internal Sealants: Types recommended by system manufacturer to remain permanently elastic, tacky, non-drying, non-migrating and weather-tight.
 1. Spandrel Panels and Exterior Column Covers [Soffits and Metal Ceilings]:
 - a. Type: Aluminum sheet, 1/8 inch thick, suitably reinforced on concealed surface for surface flatness, or prefabricated sandwich panels at manufacturer's option.
 - b. Surface flatness: 0.015 inch maximum deviation when measured with 6 inch rule.
 - c. Squareness: 0.002 inch maximum for each inch of length at panel edge.
 - d. Anchorage: Allow for expansion and contraction, to minimize oilcanning and distortion.

2.03 GLASS AND GLAZING ACCESSORIES

- A. Refer to Section 08810.

2.04 SYSTEM FABRICATION

- A. Take accurate field measurements to verify required dimensions prior to fabrication.
- B. Location of exposed joints is subject to Architect's acceptance.
- C. Provide dense EPDM continuous isolator to separate exterior pressure plates and interior framing members.
- D. Fabricate components in accord with approved shop drawings. Remove burrs and ease edges. Shop fabricate to greatest extent practicable to minimize field cutting, splicing, and assembly. Disassemble only to extent necessary for shipping and handling limitations.
- E. Steel Components:
 1. Clean surfaces after fabrication and immediately prior to application of primer in accord with SSPC-SP2 or SSPC-SP3 at manufacturer's option.
 2. Apply specified shop coat primer in accord with manufacturer's instructions to provide 2.0 minimum dry film thickness.
- F. Fabricate components true to detail and free from defects impairing appearance, strength or durability. [Fabricate custom extrusions indicated and as necessary for complete installation.]
- G. Fabricate components to allow for accurate and rigid fit of joints and corners. Match components carefully ensuring continuity of line and design. Ensure joints and connections will be flush and weather-tight. Ensure slip joints make full, tight contact and are weather-tight.
- H. Reinforce components as required at anchorage and support points, at joints, and at attachment points for interfacing work.
- I. Provide structural reinforcing within framing members where required to maintain rigidity and accommodate design loads.
- J. System design and sealants to accommodate internal weep and drainage system not visible to the exterior.
- K. Head and sill extrusions act as gutter and weep water to exterior; do not penetrate sections with fasteners.
- L. Allow for adequate clearance around perimeter of system to enable proper installation and for thermal movement within system.
- M. Separate dissimilar metals with protective coating or preformed separators to prevent contact and corrosion.
- N. Provide framing members to rigidly glaze spandrel panels and column covers within framing system.]
- O. Provide special shapes and filler pieces with tight corners.]

2.05 FINISH

- A. Organic Coating (high performance fluorocarbon):

1. Comply with requirements of AAMA 2605.
 2. Surfaces cleaned and given conversion coating pre-treatment prior to application of 0.3 mil dry film thickness of epoxy or acrylic primer following recommendations of finish coat manufacturer.
 3. Finish coat of [50%] [70%] minimum fluorocarbon resin fused to primed surfaces at temperature recommended by manufacturer, 1.0 mil minimum dry film thickness.
 4. Acceptable coatings are Trinar by Akzo Coatings, Inc.; Nubelar by Glidden Company; Fluoroceram by Morton International, Inc.; Duranar by PPG Industries Inc.; and Fluropon by Valspar Corporation.
 5. Provide in either 2, 3, or 4 coat system as required for color selected.
 6. Manufacturer's standard colors as selected by Architect.
- B. Clear Anodized:
1. Conforming to AA-M12C22A31 and AAMA 607.1.
 2. Architectural Class I, etched, medium matte, clear anodic coating, 0.7 mil minimum thickness.]
- C. Color Anodized:
1. Conforming to AA-M12C22A42 or A43 or A44 and AAMA 606.1 and 608.1.
 2. Architectural Class [I], etched, medium matte, [black] [dark bronze] [medium bronze] [light bronze] colored anodic coating, [0.7].

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 01400.
- B. Verify dimensions, tolerances, and method of attachment with other Work.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and applicable provisions of AAMA Aluminum Curtain Wall Design Guide Manual.
- B. Align assemblies plumb and level, free of warp or twist, aligning with adjacent Work.
- C. Tolerances:
 1. Limit variations from plumb and level:
 - a. 1/8 inch in 20'-0" vertically and horizontally.
 - b. 1/4 inch in 40'-0" either direction.
 2. Limit offsets in theoretical end-to-end and edge-to-edge alignment:
 - a. 1/16 inch where surfaces are flush or less than 1/2 inch out of flush and separated by not more than 2 inches.
 - b. 1/8 inch for surfaces separated by more than 2 inches.
 3. Step in face: 1/16 inch maximum.
 - a. Jog in alignment: 1/16 inch maximum.
 - b. Location: 1/4 inch maximum deviation of any member at any location.
 - c. Tolerances are not accumulative.
- D. Provide attachments and shims to permanently fasten system to building structure.
- E. Anchor securely in place, allowing for required movement, including expansion and contraction.
- F. Separate dissimilar materials at contact points, including metal in contact with masonry or concrete surfaces, with protective coating or preformed separators to prevent contact and electrolytic action.
- G. Set sill members in bed of sealant. Set other members with internal sealants and baffles to provide weather-tight construction.

- H. Water Drainage: Each light of glass shall be compartmentalized using joint plugs and silicone sealant to divert water to the horizontal weep locations. Weep holes shall be located in the horizontal pressure plates and covers to divert water to the exterior of the building.
- I. Do not apply mullion covers until building is closed in, roofing is installed and no alkaline substances can be washed from building onto curtain wall system.
- J. Glazing:
 - 1. Install glazing gaskets and sealants in accordance with manufacturer's instructions without exception; including surface preparations. Refer to Section 08810 for additional requirements.
 - 2. Outside glazed and held in place with extruded aluminum pressure plates anchored to the mullion using Drill-Flex fasteners spaced no greater than 9" on center.
- K. Fire-Safing and Curtain Wall Insulation:
 - 1. Install fire safing and curtain wall insulation specified in Section 07200 and 07270.

3.03 CLEANING

- A. Clean surfaces in compliance with manufacturer's recommendations; remove excess mastic, mastic smears, and other foreign materials.
- B. Clean metal surfaces exercising care to avoid damage.

END OF SECTION

SECTION 08950**INSULATED TRANSLUCENT FIBERGLASS SANDWICH PANEL SYSTEM****PART 1 GENERAL****1.01 SUMMARY**

- A. Section includes the insulated translucent sandwich panel system as shown and specified. Work includes providing and installing:
 - 1. Curved factory prefabricated structural insulated translucent sandwich panels.
 - 2. Aluminum installation system.
 - 3. Aluminum sill flashing.
- B. Related Sections:
 - 1. Structural Steel
 - 2. Insulated Concrete Forms
 - 3. Flashing & Sheet Metal
 - 4. Sealants

1.02 SUBMITTALS

- A. Submit manufacturer's product data. Include construction details, material descriptions, profiles and finishes of components.
- B. Submit shop drawings. Include elevations, details, dimensions and attachments to other work.
- C. Submit manufacturer's color charts showing the full range of colors available for factory finished aluminum.
 - 1. When requested, submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.
 - a. Sandwich panels: 14" x 28" units
 - b. Factory finished aluminum: 5" long sections
- D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.
- E. Submit product test reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed test reports will be acceptable if for current manufacturer and indicative of products used on this project.
 - 1. Test reports required are:
 - a. Flame Spread and Smoke Developed (UL 723)
 - b. Burn Extent (ASTM D-635)
 - c. Color Difference (ASTM D-2244)
 - d. Abrasion/Erosion Resistance (ASTM D-4060)
 - e. Impact Strength (UL 972)
 - f. Bond Tensile Strength (ASTM C-297 after aging by ASTM D-1037)
 - g. Bond Shear Strength (ASTM D-1002)
 - h. Beam Bending Strength (ASTM E-72)
 - i. Insulation U-Factor (NFRC-100)
 - j. NFRC System Certification
 - k. Condensation Resistance Factor (AAMA 1503)
 - l. Class 1 Fire Approval (FM 4881) (Optional)
 - m. Blast Analysis and Testing of Translucent Sandwich Panels Demonstrating Equivalent Performance to 1/4" Laminated Glass per DoD UFC 4-010-01. (Optional)

- F. Submit current documentation indicating regular, independent quality control monitoring under a nationally recognized building code review and listing program.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications
 - 1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten (10) consecutive years and which can show evidence of those materials being satisfactorily used on at least six (6) projects of similar size, scope and location. At least three (3) of the projects shall have been in successful use for ten (10) years or longer.
 - 2. Panel system must be listed by the International Code Council - Evaluation Service (ICC-ES) which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an approved agency.
 - 3. Quality control inspections and required testing shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with "Acceptance Criteria for Sandwich Panels" as regulated by the ICC-ES.
- B. Installer's Qualifications: Installation shall be by an experienced installer, which has been in the business of installing specified panel systems for at least five (5) consecutive years and can show evidence of satisfactory completion of projects of similar size, scope and type.
- C. Performance Requirements: The manufacturer shall be responsible for the configuration and fabrication of the complete panel system.
 - 1. When requested, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 DELIVERY STORAGE AND HANDLING

- A. Deliver panel system, components and materials in manufacturer's standard protective packaging.
- B. Store panels on the long edge, several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

1.05 WARRANTY

- A. Submit manufacturer's and installer's written warranty agreeing to repair or replace panel system work which fails in materials or workmanship within one (1) year of the date of delivery. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering and defects in accessories, insulated translucent sandwich panels and other components of the work. (Contact local representative for extended warranty periods.)

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Kalwall Corporation, tel: (800) 258-9777 - fax: (603) 627-7905 - email: info@kalwall.com

2.02 PANEL COMPONENTS

- A. Face Sheets
 - 1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.
 - a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
 - 2. Flammability of interior face sheets:
 - a. Flamespread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flamespread rating no greater than 50 (20) and smoke developed no greater than 250 (200) when tested in accordance with UL 723.
 - b. Burn extent by ASTM D-635 shall be no greater than 1".
 - c. Face sheets shall not deform, deflect or drip when subjected to fire or flame.

- d. Face sheets shall not delaminate when exposed to 200°F for 30 minutes per IBC and NBC (300°F for 25 minutes per UBC and SBC).
 3. Weatherability of exterior face sheets:
 - a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3.0 CIE Units DELTA E by ASTM D-2244 after 5 years outdoor South Florida weathering at 5 degrees facing south, determined by the average of at least three (3) white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
 - b. Erosion barrier: Exterior face shall have a permanent glass erosion barrier embedded beneath the surface to provide long-term resistance to reinforcing fiber exposure. Exterior face surface loss shall not exceed .7 mils and 40 mgs when tested in accordance with ASTM D-4060 employing CS17 abrasive wheels at a head load of 500 grams for 1000 cycles. Sacrificial surface films or coatings are not acceptable erosion barriers.
 4. Appearance:
 - a. Exterior face sheets: Smooth, 0.070" thick
 - b. Interior face sheets: Smooth, 0.045" thick
 - c. Face sheets shall not vary more than +/- 10% in thickness and be uniform in color.
 5. Strength: Exterior face sheet shall be uniform in strength, impenetrable by hand held pencil and repel an impact equal to 70 (230) ft. lbs. without fracture or tear when impacted by a 3-1/4" diameter, 5 lb. free-falling ball per UL 972.
- B. Grid Core
1. Thermally broken (aluminum) I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I- beam shall be no less than 7/16". The I-beam grid shall be machined to tolerances of not greater than +/- .002".
 2. Thermal break: Minimum 1".
- C. Laminate Adhesive
1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives."
 2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C-297 after two (2) exposures to six (6) cycles each of the aging conditions prescribed by ASTM D-1037.
 3. Minimum shear strength of the panel adhesive by ASTM D-1002 after exposure to five (5) separate conditions:
 - a. 50% Relative Humidity at 73° F: 540 PSI
 - b. 182° F: 100 PSI
 - c. Accelerated Aging by ASTM D-1037 at room temperature: 800 PSI
 - d. Accelerated Aging by ASTM D-1037 at 182° F: 250 PSI
 - e. 500 Hour Oxygen Bomb by ASTM D-572: 1400 PSI

2.03 PANEL CONSTRUCTION

- A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking thermally broken (aluminum) I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat sharp edge.
 1. Thickness: 2-3/4"
 2. Light transmission: 30 %
 3. Solar heat gain coefficient: .27
 4. U-factor by NFRC certified laboratory: 0.23 thermally broken
 5. Grid pattern: Nominal 12" x 24" shoji (reverse shoji, square, staggered).
- B. Panels shall deflect no more than 1.9" at 30 psf in 10'-0" span without a supporting frame by ASTM E-72.
- C. Panels shall withstand 1200°F fire for minimum one (1) hour without collapse or exterior flaming.

- D. Thermally broken panels:
 - 1. Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.
 - 2. Minimum CRF of 90 at center of grid cell.

2.04 BATTENS AND PERIMETER CLOSURE SYSTEM

- A. Closure system: Extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.
 - 1. Thermally broken perimeter system shall have a urethane bridge.
 - 2. Perimeter system shall be factory prefabricated "Superbreak" .
 - 3. Curved closure system may be roll formed.
- B. Sealing tape: Manufacturer's standard, pre-applied to closure system at the factory under controlled conditions.
- C. Fasteners: 300 series stainless steel screws for aluminum closures, excluding final fasteners to the building.
- D. Finish: Exposed aluminum to be manufacturer's factory applied finish that meets the performance requirements of AAMA 2604. Mill
- E. Color selected from manufacturer's standard colors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, supporting structure and installation conditions. Do not proceed with panel erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Metal Protection:
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
 - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by manufacturer.
 - 3. Where aluminum will contact pressure-treated wood, separate dissimilar materials by methods recommended by manufacturer.

3.03 INSTALLATION

- A. Install the panel system in accordance with the manufacturer's installation recommendations and approved shop drawings.
 - 1. Anchor component parts securely in place by permanent mechanical attachment system.
 - 2. Accommodate thermal and mechanical movements.
 - 3. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weather-tight construction.
- B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

3.04 CLEANING

- A. Clean the panel system inside and outside, immediately after installation, according to manufacturer's written recommendations.

END OF SECTION

SECTION 09220**PORTLAND CEMENT PLASTER (STUCCO)****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Portland cement plaster for installation over metal lath, masonry, concrete, and solid surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 05400 - Cold Formed Metal Framing: Structural metal framing for plaster.
- B. Section 09260 - Gypsum Board Assemblies: Metal stud framing and furring for plaster.

1.03 REFERENCE STANDARDS

- A. ASTM C 150 - Standard Specification for Portland Cement; 2007.
- B. ASTM C 926 - Standard Specification for Application of Portland Cement-Based Plaster; 2006.
- C. PCA EB049 - Portland Cement Plaster/Stucco Manual; Portland Cement Association; 2003.
- D. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. Product Data: Provide data on plaster materials, characteristics and limitations of products specified.
- B. Samples: Submit two samples, 4x4 inch in size illustrating finish color and texture.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with ASTM C 926.
- B. Conform to applicable code for fire rated assemblies as indicated on drawings.
 - 1. Coordinate components of fire rated assemblies with materials specified for support of plaster in other sections.

1.06 MOCK-UP

- A. Construct mock-up of exterior wall, 2 feet long by 2 feet wide, illustrating surface finish, and color.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS

- A. Comply with manufacturer's recommendations of environmental conditions affecting product installation requirements.

1.08 DESIGN REQUIREMENTS

- A. Structural (wind and axial loads)
 - 1. Design for maximum allowable deflection, normal to the plane of the wall, of L/360
 - 2. Design for wind load in conformance with code requirements. Consult applicable code compliance report
- B. Moisture Control
 - 1. Prevent the accumulation of water into or behind the stucco, either by condensation or leakage into the wall construction, in the design and detailing of the wall assembly.
 - a. Provide corrosion resistant flashing to direct water to the exterior where it is likely to penetrate components in the wall assembly, including, above window and door heads, beneath window and door sills, at roof/wall intersections, decks, abutments of lower walls with higher walls, above projecting features, and at the base of the wall.

- b. Air Leakage Prevention-prevent excess air leakage in the design and detailing of the wall assembly. Provide continuity between air barrier components in the wall assembly.
 - c. Vapor Diffusion and Condensation-- perform a dew point analysis of the wall assembly to determine the potential for accumulation of moisture in the wall assembly as a result of water vapor diffusion and condensation. Adjust insulation thickness and/or other wall assembly components accordingly to minimize the risk of condensation. Avoid the use of vapor retarders on the interior side of the wall in warm, humid climates.
 - d. On framed wall construction provide a code compliant moisture barrier over sheathing. Note: building codes vary with respect to the type moisture barrier required and the number of layers. For example, the Uniform Building Code (UBC) requires two layers of Type 1 Grade D building paper over wood-based sheathings. Check the applicable code and code compliance report for the appropriate type.
 - e. Protect sills of rough openings with barrier membrane. Where casing bead is used back-to-back at expansion joints, back joints with barrier membrane. Refer to Sto details.
- C. Grade Condition
1. Do not specify the stucco for use below grade or on surfaces subject to continuous or intermittent water immersion or hydrostatic pressure. Provide minimum 4 inch (100 mm) clearance above earth grade, minimum 2 inch (51 mm) clearance above finished grade (pavers/sidewalk). Provide increased clearance in freeze/thaw climate zones.
- D. Sloped surfaces, including Foam Trim and Projecting Architectural Features attached to stucco.
1. Avoid the use of stucco on build-outs or weather exposed sloped and horizontal surfaces (refer to 2 and 3 below).
 2. Build out trim and projecting architectural features from the stucco wall surface with code compliant EPS foam. All foam trim and projecting architectural features must have a minimum 1:2 [27°] slope along their top surface. All foam horizontal reveals must have a minimum 1:2 [27°] slope along their bottom surface. Increase slope for northern climates to prevent accumulation of ice/snow and water on surface. Where trim/feature or bottom surface of reveal projects more than 2 inches (51 mm) from the face of the wall plane, protect the top surface with waterproof base coat. Avoid the use of trim and features that exceed the maximum allowable thickness of EPS permitted by code (typically 4 inches [100 mm]) unless approved by the code official. Periodic inspections and increased maintenance may be required to maintain surface integrity of finishes on weather exposed sloped surfaces. Limit projecting features to easily accessible areas and limit total area to facilitate maintenance and minimize maintenance burden. Refer to Sto details.
 3. Do not use EPS foam on weather exposed projecting ledges, sills, or other projecting features unless supported by framing or other structural support and protected with metal coping or flashing. Refer to Sto details.
- E. Joints
1. Provide two piece expansion joints in the stucco system where building movement is anticipated: at joints in the substrate or supporting construction, where the system is to be installed over dissimilar construction or substrates, at changes in building height, at floor lines, at columns and cantilevered areas. Provide one piece expansion joints every 144 ft² (13 m²)*. Cut and wire tie lath to the expansion joint accessory so lath is discontinuous beneath the accessory. Do not exceed length to width ratio of 2-1/2:1 in expansion joint layout and do not exceed more than 18 feet (5.5 m) in any direction without an expansion joint. Where casing bead is used back-to-back as the expansion joint, back the joint with barrier membrane.
 - a. *Note: the requirement for a one piece expansion joint every 144 ft² (13 m²) may be waived in the following cases: 1. when two-piece expansion joints exist every 144 ft² (13 m²), and 2. on solid substrates without metal lath such as cast-in-place concrete and concrete masonry units provided joints in the supporting construction exist at appropriate intervals and they are reflected in the stucco. In such cases joint spacing in the stucco shall not exceed 250 ft² (23 m²).
 2. Provide one piece expansion joints at through wall penetrations, for example, above and below doors or windows.

- a. Note: the requirement for one piece expansion joints at through wall penetrations may be waived in the following case: when another type of expansion joint is provided in lieu of the one piece expansion joint, for example, back-to-back casing beads.
 3. Provide minimum 3/8 inch (9 mm) wide joints where the system abuts
 - a. windows, doors and other through wall penetrations.
 4. 4. Provide appropriate accessories at stucco terminations and joints.
 5. 5. Provide appropriate sealant at stucco terminations.
 6. Indicate location of joints, accessories and accessory type on architectural drawings.
- F. Fire Protection
1. Do not use foam trim in excess of 4 inches (100 mm) thick unless approved by the code official on buildings of noncombustible construction.
 2. Refer to the applicable code compliance report for other limitations and fire-resistive assemblies that may apply.
- G. Solid Substrates
1. Provide surface plane tolerance not to exceed 1/4 inch in 10 feet (6 mm in 3.0 m).
 2. Concrete-prevent the use of form oil, curing compounds or other bond breakers that inhibit bond to the surface or provide for their removal.
 3. Concrete Masonry-provide open texture concrete masonry units with flush joints.
- H. Stucco Thickness: General
1. Direct Application to Concrete or Concrete Masonry: stucco thickness shall not exceed 1/2 inch (13 mm) applied in one or two coats.
 2. 2. Application to Metal Plaster Bases:
 - a. Woven wire fabric lath: stucco thickness shall be 1/2 inch (13 mm) applied in one or two coats
 - b. Galvanized diamond mesh metal lath:
 - 1) 1.75 lb/yd² (1 kg/m²): stucco thickness shall be 1/2 inch (13 mm) applied in one or two coats.
 - 2) Minimum 2.5 lb/yd² (1.4 kg/m²): stucco thickness shall be 1/2 to 7/8 inch (13 to 22 mm). 1/2 inch (13 mm) thickness shall be applied in one or two coats. Thicknesses in excess of 1/2 inch up to 7/8 inch (13 up to 22 mm) shall be applied in two coats.
 3. Thickness shall be uniform throughout the wall area.
- I. Stucco Thickness: Specific
1. See SBCCI PST & ESI Evaluation Report No. 9838B and ICBO ES Evaluation Report No.3899 for required thickness of listed wind resistant and fire-resistive assemblies

1.09 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.
- B. Protect coatings (pail products) from freezing and temperatures in excess of 90°F (32°C). Store away from direct sunlight.
- C. Protect Portland cement based materials (bag products) from moisture and humidity. Store under cover off the ground in a dry location.

1.10 COORDINATION/SCHEDULING

- A. Provide minimum 28 day cure of concrete and concrete masonry units before the installation of stucco.
- B. For load bearing concrete masonry and stud wall assemblies, commence the stucco installation after completion of all floor, roof construction and other construction that imposes dead loads on the walls to prevent excessive deflection (and potential cracking) of the stucco.
- C. Sequence interior work such as drywall installation prior to stucco installation to prevent stud distortion (and potential cracking) of the stucco.

- D. Provide site grading such that the stucco terminates above earth grade minimum 4 inches (100 mm) and above finished grade (pavers/sidewalk) minimum 2 inches (51 mm). Provide increased clearance in freeze/thaw climate zones.
- E. Provide protection of rough openings before installing windows, doors, and other penetrations through the wall and provide sill flashing. Coordinate installation of moisture barrier with window and door installation to provide weather proofing of the structure and to prevent moisture infiltration and excess air infiltration.
- F. Install window and door head flashing immediately after windows and doors are installed.
- G. Install diverter flashings wherever water can enter the wall assembly to direct water to the exterior.
- H. Install copings and sealant immediately after installation of the stucco and when finish coatings are dry.
- I. Attach penetrations through stucco to structural support and provide water tight seal at penetrations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sto Corp.
- B. Provide stucco, primer and finish from single source manufacturer.
- C. Substitutions are acceptable provided material meets these specifications, design requirements and installation instructions are followed. See Section 01600 - Product Requirements.

2.02 SURFACE PREPARATION

- A. Sto Bonding Agent--acrylic bonding agent for brush or roller application to prepared CMU surfaces.

2.03 MOISTURE BARRIER (supplied by others)

- A. Minimum 14 lb/100 ft² (0.683 kg/m²) vapor permeable asphalt saturated felt in compliance with ASTM D 226 or equal.

2.04 LATH

- A. Minimum No. 20 gauge 1 inch (25 mm) self-furred galvanized steel woven wire fabric in compliance with ASTM C 1032, or minimum 1.75 lb/yd² [1 kg/m²] galvanized steel diamond mesh metal lath in compliance with ASTM C 847 (recommended for residential [one and two family dwellings] and light commercial construction)
- B. Minimum 2.5 lb./yd² (1.4 kg/m²) self-furred galvanized steel diamond mesh metal lath in compliance with ASTM C 847 (recommended for residential and commercial construction).

2.05 MECHANICAL FASTENERS (supplied by others)

- A. Appropriate non-corroding fasteners, depending on the type framing or substrate:
 - 1. Wood Framing--minimum 11 gauge, 7/16 inch (11 mm) diameter head galvanized roofing nails with minimum ¾ inch (19mm) penetration into studs or minimum #8 Type S wafer head fully threaded corrosion resistant screws with minimum ¾ inch (19 mm) penetration into studs.
 - 2. Steel Framing--minimum #8 Type S or S-12 wafer head fully threaded corrosion resistant screws with minimum 3/8 inch (10 mm) penetration into studs.
 - 3. Concrete or Masonry--minimum # 8 wafer head fully threaded corrosion resistant screws for masonry with minimum 1 inch (25 mm) penetration into substrate.
- B. Tie Wire--18 gauge galvanized and annealed low-carbon steel in compliance with ASTM A 641 with Class I coating.

2.06 ACCESSORIES

- A. Weep screed, casing bead, corner bead, corner lath, expansion and control joint accessories. All accessories shall meet the requirements of ASTM C 1063 and its referenced documents:
 - 1. Zinc in compliance with ASTM B 69.
 - 2. Galvanized metal in compliance with ASTM A 653 with G60 coating.
- B. All accessories shall have perforated or expanded flanges and shall be designed with grounds for the specified thickness of stucco.

2.07 JOB MIXED INGREDIENTS

- A. Water-clean and potable.
- B. Clean, well graded sand free of deleterious materials in compliance with ASTM C 897.
- C. Stucco Admixture
 - 1. Sto Bonding Agent-acrylic admixture for StoPowerwall Stucco.

2.08 STUCCO

- A. Sto Powerwall® Stucco ¾ factory proportioned, fiber reinforced portland cement based stucco for trowel or pump application, field mixed with graded sand (ASTM C 897) and water.
- B. Sto Powerwall® Acrylic Modified Stucco ¾ acrylic-modified, factory proportioned, fiber reinforced portland cement based stucco, field mixed with graded sand (ASTM C 897), water and Sto Bonding Agent.

2.09 FOAM BUILD-OUTS

- A. Adhesive
 - 1. Sto BTS-Plus-one component, polymer modified, cement based high build adhesive.
- B. Insulation Board
 - 1. Sto EPS Insulation Board--nominal 1.0 lb/ft³ (16 kg/m³) Expanded Polystyrene (EPS) Insulation Board in compliance with ASTM C 578 Type I requirements, and EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board. (Note: minimum required thickness is 1 inch [25 mm] and maximum allowable thickness is typically 4 inches [100 mm] for noncombustible type construction unless thicker dimensions are approved by the code official).
- C. Reinforcing Mesh (select one):
 - 1. Sto Mesh--nominal 4.5 oz./yd² (153 g/m²), symmetrical, interlaced open-weave glass fiber fabric made with minimum 20 percent by weight alkaline resistant coating for compatibility with Sto materials (achieves Standard Impact Classification).
 - 2. Sto Detail Mesh--nominal 4.2 oz/yd² (143 g/m²), flexible, symmetrical, interlaced glass fiber fabric, with alkaline resistant coating for compatibility with Sto materials (used for standard EIFS backwrapping and aesthetic detailing).
- D. Base Coats (select one or both):
 - 1. Sto BTS-Plus-one-component polymer modified cement based high build base coat with less than 33 percent Portland cement content by weight and capable of achieving minimum 1/16 inch (1.6 mm) thickness in one pass.
 - 2. Sto Flexyl-fiber reinforced acrylic based waterproof base coat mixed with Portland cement (for use as a waterproof base coat to waterproof foundations, parapets, splash areas, trim and other projecting architectural features).

2.10 PRIMER

- A. Sto Primer-acrylic based tinted primer.

2.11 FINISH COAT

- A. Sto acrylic or silicone enhanced textured wall finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify the suitability of existing conditions before starting work.
- B. Masonry: Verify joints are cut flush and surface is ready to receive work of this section. Verify no bituminous or water repellent coatings exist on masonry surface.
- C. Metal Lath and Accessories: Verify lath is flat, secured to substrate, and joint and surface perimeter accessories are in place.
- D. Mechanical and Electrical: Verify services within walls have been tested and approved.

3.02 INSTALLATION

- A. Install stucco in conformance with manufacturer's published instructions
- B. Apply plaster in accordance with ASTM C 926.

3.03 PROTECTION

- A. Provide protection of installed materials from water infiltration into or behind them.
- B. Provide protection of installed stucco from dust, dirt, precipitation, and freezing.
- C. Provide protection of installed primer and finish from dust, dirt, precipitation, freezing and continuous high humidity until fully dry.

3.04 TOLERANCES

- A. Maximum Variation from True Flatness: 1/8 inch in 10 feet.

END OF SECTION

SECTION 09260**GYPSUM BOARD ASSEMBLIES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Shaft wall system.
- E. Acoustic insulation.
- F. Gypsum sheathing.
- G. Gypsum wallboard.
- H. Joint treatment and accessories.
- I. Water-resistive barrier over exterior wall sheathing.

1.02 RELATED REQUIREMENTS

- A. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 06100 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 07900 - Joint Sealers: Acoustic sealant.

1.03 REFERENCE STANDARDS

- A. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)
- B. ANSI A108.11 - American National Standard for Interior Installation of Cementitious Backer Units; 1999 (R2005).
- C. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.
- D. ASTM C 475/C 475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2002 (Reapproved 2007).
- E. ASTM C 645 - Standard Specification for Nonstructural Steel Framing Members; 2007.
- F. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2006.
- G. ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2007.
- H. ASTM C 840 - Standard Specification for Application and Finishing of Gypsum Board; 2007.
- I. ASTM C 954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2007.
- J. ASTM C 1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2007.
- K. ASTM C 1278/C 1278M - Standard Specification for Fiber-Reinforced Gypsum Panel; 2007a.
- L. ASTM C 1280 - Standard Specification for Application of Gypsum Sheathing; 2007.

- M. ASTM C 1396/C 1396M - Standard Specification for Gypsum Board; 2006a.
- N. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction; 2005.
- O. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2004.
- P. ASTM E 413 - Classification for Rating Sound Insulation; 2004.
- Q. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; 2007.
- R. GA-600 - Fire Resistance Design Manual; Gypsum Association; 2006.
- S. ICC (IBC) - International Building Code; 2006.
- T. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- D. Test Reports: For all stud framing products that do not comply with ASTM C 645 or C 754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- E. Samples: Submit three samples of gypsum board finished with proposed texture application, 12 by 12 inches in size, illustrating finish color and texture.
- F. LEED Submittals:
 - 1. For gypsum wallboard, submit documentation of recycled content and location of manufacture.
 - 2. For steel products, submit documentation of steel mill process, location of mill, and location of manufacture.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C 840 and GA-216.
- B. Interior Partitions: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E 413, based on tests conducted in accordance with ASTM E 90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 - 2. Acoustic Attenuation: STC of 50-54 calculated in accordance with ASTM E 413, based on tests conducted in accordance with ASTM E 90.
- D. Fire Rated Assemblies: Provide completed assemblies as indicated in the drawings

2.02 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. Clark Western Building Systems: www.clarkwestern.com.
 - 2. Dietrich Metal Framing: www.dietrichindustries.com.
 - 3. MarinoWare: www.marinoware.com.
 - 4. Phillips Manufacturing Company: www.phillipsmfg.com.
 - 5. The Steel Network, Inc: www.SteelNetwork.com.

- B. Non-Loadbearing Framing System Components: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
 - 1. Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
 - 2. Studs: "C" shaped with flat or formed webs with knurled faces.
 - 3. Runners: U shaped, sized to match studs.
 - 4. Ceiling Channels: C shaped.
 - 5. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
- C. Shaft Wall Studs and Accessories: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 and specified performance requirements.
- D. Ceiling Hangers: Type and size as specified in ASTM C 754 for spacing required.
- E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. Material: ASTM A 653/A 653M steel sheet, SS Grade 50/340, with G60/Z180 hot dipped galvanized coating.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum: www.americangypsum.com.
 - 2. CertainTeed Corporation: www.certainteed.com.
 - 3. Georgia-Pacific Gypsum LLC: www.gp.com/gypsum.
 - 4. Lafarge North America Inc: www.lafargenorthamerica.com.
 - 5. National Gypsum Company: www.nationalgypsum.com.
 - 6. PABCO Gypsum: www.pabco gypsum.com.
 - 7. Temple-Inland Inc: www.templeinland.com.
 - 8. USG Corporation: www.usg.com.
- B. Wallboard: Paper-faced gypsum wallboard as defined in ASTM C 1396/C 1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. Unfaced fiber-reinforced gypsum panels as defined in ASTM C 1278/C 1278M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
 - 3. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.
 - 4. Paper-Faced Products:
 - a. American Gypsum; EagleRoc Regular Gypsum Wallboard and FireBloc Type X Gypsum Wallboard.
 - b. CertainTeed Corporation; ProRoc Brand Gypsum Board.
 - c. CertainTeed Corporation; ProRoc Brand Abuse Resistant Gypsum Board.
 - d. Georgia-Pacific Gypsum LLC; ToughRock Gypsum Wallboard.
 - e. Lafarge North America Inc; Regular Drywall and Firecheck Type X and Type C.
 - f. National Gypsum Company; Gold Bond Brand Gypsum Wallboard.
 - g. Pacific Coast Building Products, Inc; PABCO Regular Gypsum Wallboard and PABCO Flame Curb.
 - h. Temple-Inland Inc; Gypsumboard.

- i. USG Corporation; Sheetrock Brand Gypsum Panels.
- C. Exterior Sheathing Board: As specified in Section 05400.
- D. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
 - 1. Paper Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C 1396/C 1396M; water-resistant faces.
 - 2. Products:
 - a. American Gypsum; Shaft Liner.
 - b. CertainTeed Corporation; ProRoc Brand Shaftliner Type X.
 - c. Georgia-Pacific Gypsum LLC; DensGlass Ultra Shaftliner (mold-resistant).
 - d. National Gypsum Company; Gold Bond Brand 1" Fire-Shield Shaftliner.
 - e. National Gypsum Company; Gold Bond Brand 1" Fire-Shield Shaftliner XP (mold-resistant).
 - f. Pacific Coast Building Products, Inc; PABCORE Gypsum Shaftliner Board type X.
 - g. Temple-Inland Inc; SilentGuard Gypsum Shaftliner.
 - h. USG Corporation; Sheetrock Gypsum Liner Panels.
 - i. USG Corporation; Sheetrock Gypsum Liner Panels--Enhanced (mold-resistant).

2.04 ACCESSORIES

- A. Acoustic Insulation: ASTM C 665; preformed glass fiber, friction fit type, unfaced. Thickness: 3 inch.
- B. Acoustic Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board.
- C. Water-Resistive Barrier: No. 15 asphalt felt.
- D. Joint Materials: ASTM C 475 and as recommended by gypsum board manufacturer for project conditions.
 - 1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 - 2. Ready-mixed vinyl-based joint compound.
 - 3. Chemical hardening type compound.
- E. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C 1002; self-piercing tapping type; cadmium-plated for exterior locations.
- F. Screws for Attachment to Steel Members From 0.033 to 0.112 inch in Thickness: ASTM C 954; steel drill screws for application of gypsum board to loadbearing steel studs.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Install studs at spacing required to meet performance requirements.
- B. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.
 - 1. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.03 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C 754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling and soffit system to a tolerance of 1/1200.
- C. Studs: Space studs as indicated.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Standard Wall Furring: Install at masonry and ICF walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
- F. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.
- G. Furring for Fire Ratings: Install as required for fire resistance ratings indicated and to GA-600 requirements.
- H. Blocking: Install wood blocking for support of:
 1. Framed openings.
 2. Wall mounted cabinets.
 3. Plumbing fixtures.
 4. Toilet partitions.
 5. Toilet accessories.
 6. Wall mounted door hardware.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

- A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board perpendicular to framing, with ends and edges occurring over firm bearing.
- C. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- D. Exterior Sheathing: Comply with ASTM C 1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
 1. Paper-Faced Sheathing: Immediately after installation, protect from weather by application of water-resistive barrier.
- E. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.
- F. Installation on Metal Framing: Use screws for attachment of all gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination.
- G. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board and exterior gypsum soffit board with sealant.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.

- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.07 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C 840, as follows:
 - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 2. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.

3.08 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09300**TILE****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Cementitious backer board as tile substrate.
- D. Stone thresholds.
- E. Ceramic accessories.
- F. Ceramic trim.

1.02 RELATED REQUIREMENTS

- A. Section 03505 - Self-Leveling Underlayment.
- B. Section 05810 - Expansion Joint Cover Assemblies: Expansion joint components.
- C. Section 07140 - Fluid-Applied Waterproofing.
- D. Section 07900 - Joint Sealers.

1.03 REFERENCE STANDARDS

- A. ANSI A108 Series/A118 Series/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2005.
 - 1. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2005).
 - 2. ANSI A108.1c - Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2005).
 - 3. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive; 1999 (R2005).
 - 4. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar; 1999 (R2005).
 - 5. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy; 1999 (R2005).
 - 6. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (R2005).
 - 7. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 1999 (R2005).
 - 8. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 1999 (R2005).
 - 9. ANSI A108.11 - American National Standard for Interior Installation of Cementitious Backer Units; 1999 (R2005).
 - 10. ANSI A118.1 - American National Standard Specifications for Dry-Set Portland Cement Mortar; 1999 (R2005).
 - 11. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 1999 (R2005).
 - 12. ANSI A118.4 - American National Standard Specifications for Latex-Portland Cement Mortar; 1999 (R2005).

13. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation; 1999 (R2005).
14. ANSI A118.7 - American National Standard Specifications for Polymer Modified Cement Grouts for Tile Installation; 1999 (R2005).
15. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 1999 (R2005).
16. ANSI A136.1 - American National Standard for Organic Adhesives for Installation of Ceramic Tile; 1999 (R2005).
17. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2008.

B. ASTM C 847 - Standard Specification for Metal Lath; 2006.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
- D. Samples: Mount tile and apply grout on two plywood panels, minimum 18 x 18 inches in size illustrating pattern, color variations, and grout joint size variations.
- E. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.
- F. LEED Submittal: Documentation of recycled content and location of manufacture.

1.05 QUALITY ASSURANCE

A. Maintain one copy of TCA Handbook and ANSI A108 Series/A118 Series on site.

1.06 MOCK-UP

- A. See Section 01400 - Quality Requirements, for general requirements for mock-up.
- B. Construct tile mock-up where indicated on the drawings, incorporating all components specified for the location.
 1. Minimum size of mock-up is indicated on the drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers: All products by the same manufacturer.
 1. American Olean: www.americanolean.com.
 2. Dal-Tile Corporation: www.daltile.com.
 3. Summitville Tiles, Inc: www.summitville.com.
 4. Substitutions: See Section 01600 - Product Requirements.
- B. Ceramic Mosaic Tile: ANSI A137.1
 1. Colors: To be selected from manufacturer's standard range.
- C. Glazed Wall Tile: ANSI A137.1
 1. Colors: To be selected from manufacturer's standard range.
- D. Quarry Tile at Kitchen areas: ANSI A137.1, and as follows:
 1. Quarry Tile manufactured by Dal-Tile or approved equivalent product.

2. Colors: Red Blaze.
3. Texture: Abrasive Grain

2.02 TRIM AND ACCESSORIES

- A. Ceramic Accessories: Glazed finish, same color and finish as adjacent field tile; same manufacturer as tile.
- B. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
 1. Manufacturer: Same as for tile.
- C. Thresholds: Marble, white or gray, honed finish; 2 inches wide by full width of wall or frame opening; 1/2 inch thick; beveled one long edge with radiused corners on top side; without holes, cracks, or open seams.
 1. Applications: Provide at the following locations:
 - a. At doorways where tile terminates.

2.03 ADHESIVE MATERIALS

- A. Manufacturers:
 1. Bonsal American, Inc: www.sakrete.com
 2. Bostik Inc: www.bostik-us.com.
 3. Mapei Corporation: www.mapei.com.
 4. Substitutions: See Section 01600 - Product Requirements.
- B. Organic Adhesive: ANSI A136.1, thinset bond type; use Type I in areas subject to prolonged moisture exposure.
- C. Epoxy Adhesive: ANSI A118.3,, thinset bond type.
- D. Tile Setting Adhesive: Elastomeric, waterproof, liquid applied, .

2.04 MORTAR MATERIALS

- A. Manufacturers:
 1. Bonsal American, Inc: www.sakrete.com
 2. Bostik Inc: www.bostik-us.com.
 3. Custom Building Products: www.custombuildingproducts.com.
 4. Substitutions: See Section 01600 - Product Requirements.
- B. Mortar Bond Coat Materials:
 1. Dry-Set Portland Cement type: ANSI A118.1.
 2. Latex-Portland Cement type: ANSI A118.4.

2.05 GROUT MATERIALS

- A. Manufacturers:
 1. Bonsal American, Inc: www.sakrete.com
 2. Bostik Inc: www.bostik-us.com.
 3. Custom Building Products: www.custombuildingproducts.com.
 4. Substitutions: See Section 01600 - Product Requirements.
- B. Standard Grout: Any type specified in ANSI A118.6 or A118.7.

2.06 ACCESSORY MATERIALS

- A. Cleavage Membrane: No. 15 asphalt saturated felt.
- B. Uncoupling Membrane: 1/8 inch thick polyurethane matting with three-dimensional grid structure with dovetail shaped cavities and fleece webbing laminated to the underside to provide a mechanical bond to the substrate adhesive (DITRA).
- C. Membrane at Walls: No. 15 asphalt saturated felt.

- D. Reinforcing Mesh: 2 x 2 inch size weave of 16/16 wire size; welded fabric, galvanized.
- E. Metal Lath: ASTM C 847, Flat diamond mesh, of weight to suit application, galvanized finish.
- F. Cementitious Backer Board: ANSI A118.9; High density, cementitious, glass fiber reinforced, 1/2 inch thick; 2 inch wide coated glass fiber tape for joints and corners.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Install cementitious backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of dry-set mortar to a feather edge.

3.03 INSTALLATION - GENERAL

- A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1 through A108.13, manufacturer's instructions, and TCA Handbook recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install ceramic accessories rigidly in prepared openings.
- G. Install thresholds where indicated.
- H. Sound tile after setting. Replace hollow sounding units.
- I. Keep expansion joints free of adhesive or grout. Apply sealant to joints.
- J. Allow tile to set for a minimum of 48 hours prior to grouting.
- K. Grout tile joints. Use standard grout unless otherwise indicated.
- L. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCA Handbook Method F113, dry-set or latex-portland cement bond coat, with standard grout, unless otherwise indicated.

1. Use uncoupling membrane under all tile unless other underlayment is indicated.

3.05 INSTALLATION - FLOORS - MORTAR BED METHODS

- A. Over interior concrete substrates, install in accordance with TCA Handbook Method F111, with cleavage membrane, unless otherwise indicated.
- B. Cleavage Membrane: Lap edges and ends.
- C. Mortar Bed Thickness: 5/8 inch, unless otherwise indicated.

3.06 INSTALLATION - WALL TILE

- A. Over cementitious backer units on studs, install in accordance with TCA Handbook Method W244, using membrane at toilet rooms and kitchens.
- B. Over interior concrete and masonry install in accordance with TCA Handbook Method W202, thin-set with dry-set or latex-portland cement bond coat.

3.07 CLEANING

- A. Clean tile and grout surfaces.

3.08 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

SECTION 09511**SUSPENDED ACOUSTICAL CEILINGS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM C 635 - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2004.
- B. ASTM C 636/C 636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2006.
- C. ASTM E 580/E 580M - Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint; 2006.
- D. ASTM E 1264 - Standard Classification for Acoustical Ceiling Products; 1998 (Reapproved 2005).
- E. CAL (CHPS LEM) - Low-Emitting Materials Product List; California Collaborative for High Performance Schools (CHPS); current edition at www.chps.net/manual/lem_table.htm.
- F. GEI (SCH) - GREENGUARD "Children and Schools" Certified Products; GREENGUARD Environmental Institute; current listings at www.greenguard.org.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning.
- C. Product Data: Provide data on suspension system components and acoustical units.
- D. Samples: Submit two samples 3x3 inch in size illustrating material and finish of acoustical units.
- E. Manufacturer's Installation Instructions: Indicate special procedures.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01600 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.
- G. LEED Submittal: Documentation of recycled content and location of manufacture.

PART 2 PRODUCTS**2.01 ACOUSTICAL UNITS**

- A. Manufacturers:
 - 1. Armstrong World Industries, Inc: www.armstrong.com.
 - 2. CertainTeed Corporation: www.certainteed.com.
 - 3. Pinta Acoustic, Inc: www.pinta-acoustic.com/link.
 - 4. USG: www.usg.com.

5. Substitutions: See Section 01600 - Product Requirements.
- B. Acoustical Units - General: ASTM E 1264, Class A.
- C. Acoustical Panels Type 1: Painted mineral fiber, ASTM E 1264 Type III, with the following characteristics:
 1. VOC Content: As specified in Section 01616.
 2. VOC Content: Certified as Low Emission by one of the following :
 - a. GreenGuard Children and Schools; www.greenguard.org.
 - b.
 - c. Product listing in the CHPS Low-Emitting Materials Product List at; www.chps.net/manual/lem_table.htm.
 3. Size: 24 x 48 inches.
 4. Surface Color: White.
- D. Acoustical Panels Type 2: Plastic faced mineral fiber, ASTM E 1264 Type IV, with the following characteristics:
 1. Size: 24 x 48 inches.

2.02 SUSPENSION SYSTEM(S)

- A. Manufacturers:
 1. Same as for acoustical units.
 2. Substitutions: See Section 01600 - Product Requirements.
- B. Suspension Systems - General: ASTM C 635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
- C. Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; intermediate-duty.
- D. Exposed Aluminum Suspension System: Extruded aluminum; light-duty.

2.03 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Perimeter Moldings: Same material and finish as grid.
 1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
- C. Acoustical Sealant For Perimeter Moldings: Specified in Section 07900.
- D. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.
- E. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C 636/C 636M, ASTM E 580/E 580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Locate system on room axis according to reflected plan.
- D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

- E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.
- J. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
 - 2. Overlap and rivet corners.

3.03 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install units after above-ceiling work is complete.
- E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- F. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.
 - 2. Double cut and field paint exposed reveal edges.

3.04 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION

SECTION 09650**RESILIENT FLOORING****PART 1 - GENERAL****1.01 SUMMARY**

- A. The work of this Section includes:
1. Rubber tile flooring.
 2. Rubber sheet flooring.
 3. Rubber wall base.
 4. Rubber stairtreads and accessories.
- B. Related Sections:
1. Section 03300 - Cast-In-Place Concrete; concrete substrate; slab surface tolerances; vapor retarder for applications on or below grade; 83/90 degree riser and tread edge angle for stairtread and nosing's.
 2. Section 06100 - Rough Carpentry; plywood substrate; surface tolerances.
 3. Section 10270 - Access Flooring; resilient floor covering for access panels.
- C. References
1. ASTM D 2047 Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
 2. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
 3. ASTM E 648 Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
 4. ASTM E 662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
 5. ASTM E 2180 Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) in Polymeric or Hydrophobic Materials
 6. ASTM F 150 Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
 7. ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
 8. ASTM F 970 Standard Test Method for Static Load Limit
 9. ASTM F 1344 Standard Specification for Rubber Floor Tile
 10. ASTM F 1859 Standard Specification for Rubber Sheet Floor Covering Without Backing
 11. ASTM F 1860 Standard Specification for Rubber Sheet Floor Covering With Backing
 12. ASTM F 1861 Standard Specification for Resilient Wall Base
 13. ASTM F 2169 Standard Specification for Resilient Stair Treads
 14. ASTM F 2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
 15. ASTM F 2420 Standard Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood
 16. ASTM G 21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
 17. FTM 4046 101 Static Decay
 18. ESD S7.1 100 Resistive Characterization of Flooring Materials
 19. ESD STM 97.2 Floor Materials and Footwear - Voltage Measurement on a Person
 20. ASTM E 989 Standard Classification for Determination of Impact Insulation Class (IIC)
 21. ISO 140-8 Acoustics Measurement of Sound Insulation in Buildings and of Building Elements-Part 8: Laboratory Measurements of the Reduction of Transmitted Impact Noise by Floor Coverings on a Heavyweight Floor
 22. NFPA 253 Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Energy Source
 23. NFPA 258 Test Method for Specific Density of Smoke Generated by Solid Materials

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, installation guide, and maintenance guide for each material proposed for use (available on www.nora.com).
- B. Samples: Submit two 3 inch by 3 inch verification samples of each type of product specified in color selected for use. Other size options are 6 inch by 6 inch, 3 inch by 6 inch (serra only) or 2 inches wide (stairtreads only).
- C. MSDS (Material Safety Data Sheets) are available for adhesives, heat weld rod and cold weld and cleaning agents.

1.03 QUALITY ASSURANCE

- A. Manufacturer: Provide resilient flooring manufactured by a firm with a minimum of 10 years experience with resilient flooring of type's equivalent to those specified. Manufacturers proposed for use, which are not named in this Section, shall submit evidence of ability to meet performance requirements specified not less than 10 days prior to bid date.
 - 1. Color Matching: Provide resilient flooring products, including wall base and accessories, from one manufacturer to ensure color matching.
 - 2. Manufacturer capable of providing field service representation.
- B. Installer Qualifications: Installer shall be nora® approved for the requirements of the project or INSTALL (International Standards & Training Alliance) resilient certified for the requirements of the project.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.
- B. Deliver materials sufficiently in advance of installation to condition materials to room temperature prior to installation.

1.05 PROJECT CONDITIONS

- A. Maintain temperature at service temperature or 68° F (20° C) plus or minus 5° F (3° C) in spaces to receive resilient flooring. Specified temperature shall be maintained at least 48 hours before, during, and 72 hours after installation.

1.06 WARRANTY

- A. Provide manufacturer's standard one-year warranty against defects in manufacturing and workmanship of resilient flooring products. Provide manufacturer's warranty as specified under each product as applicable, including limited wear, defect and conductivity.

1.07 EXTRA MATERIALS

- A. Furnish full size units equal to 2 percent of quantity of resilient flooring installed as extra materials. Properly label and package extra materials. Deliver to Owner's designated storage area.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Provide resilient flooring by nora systems, Inc., 94 Glenn Street, Lawrence, MA 01843; telephone 800-332-NORA, or 978-689-0530; fax 978-975-0110. www.nora.com

2.02 RESILIENT TILE FLOORING

- A. Rubber Tile Flooring for Extra Heavy Traffic:
 - 1. Product Name: norament® 925, Article 354, raised round pastilles.
 - a. Tile Size: 0.16 inches (4.0 mm) overall thickness, 0.02 inches (0.5 mm) raised pastilles thickness, 39.45 inches by 39.45 inches (1002 mm by 1002 mm).

- b. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 2. Product Name: norament® grano, Article 1880, hammered surface.
 - a. Tile Size: 0.14 inches (3.5 mm) overall thickness, 39.45 inches by 39.45 inches
 - b. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 3. Product Name: norament® strada, Article 1870, unique cubic surface.
 4. Tile Size: 0.14 inches (3.5 mm) overall thickness, 39.45 inches by 39.45 inches (1002 mm by 1002 mm).
 5. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 6. Product Name: norament® luxor, Article 256, mat-silk surface.
 - a. Tile Size: 0.14 inches (3.5 mm) overall thickness, 19.8 inches by 19.8 inches (503 mm by 503 mm).
 - b. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 7. Product Name: norament® serra, Article 3016, landscape surface.
 - a. Tile Size: 0.14 inches (3.5 mm) overall thickness, 39.45 inches by 19.72 inches (1002 mm by 501 mm).
 - b. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 8. Limited Wear Warranty: 10 years.
 9. Standard: ASTM F 1344, for solid color homogeneous tiles and through-mottled tiles as applicable.
 10. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss < 0.60.
 11. Hardness: ASTM D 2240, Shore A, > 85.
 12. Slip Resistance: Static coefficient of friction (James Test), ASTM D 2047, > 0.5.
 13. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result > 0.45 watts per square centimeter, Class 1.
 14. Bacteria Resistance: Products shall be resistant to bacteria, fungi, and micro-organism activity, according to ASTM E 2180 and ASTM G 21.
 15. Color: As selected.
 16. Static Load: Per ASTM F-970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be < 0.005".
 17. Shine Cleaning Products shall have a gloss value < 30 units. Floor surfaces shall be easily cleaned and not require coatings and stripping or the use of chemicals that may be hazardous to human health. Products shall be free of teratogenic, mutagenic or anything known to be carcinogenic.
- B. Rubber Tile for Commercial Traffic:
 1. Product Name: norament® 825 (round), Article 1902, raised round pastilles.
 - a. Tile Size: 0.13 inches (3.2 mm) overall thickness, 0.02 inches (0.5 mm) raised pattern thickness, 19.8 inches by 19.8 inches (503 mm by 503 mm).
 - b. Material: nora® rubber Compound 825 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 37%.
 2. Product Name: norament® 825 (hammered) surface, Article 1910.
 - a. Tile Size: 0.11 inches (2.7 mm) overall thickness, 19.8 inches by 19.8 inches (503 mm by 503 mm)
 - b. Material: nora® rubber Compound 825 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 37%.
 3. Product Name: noraplan® environcare™, Article 2462, smooth surface.
 - a. Tile Size: 0.08 inches (2.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm).
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
 4. Product Name: noraplan® environcare™, Article 2463, smooth surface.

- a. Tile Size: 0.12 inches (3.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm).
- b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
5. Product Name: noraplan® uni, Article 2461, (inlays and borders) smooth surface.
 - a. Tile Size: 0.08 inches (2.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm).
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
6. Product Name: noraplan® mega, Article 206, smooth surface.
 - a. Tile Size: 0.08 inches (2.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm)
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
7. Product Name: noraplan® logic, Article 2230, smooth surface.
 - a. Tile Size: 0.08 inches (2.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm).
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
8. Product Name: noraplan® eco, Article 2490, smooth surface.
 - a. Tile Size: 0.08 inches (2.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm)
 - b. Material: nora® rubber Compound 910 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
9. Limited Wear Warranty: 10 years for norament® 825. 5 years for noraplan®.
10. Standard: ASTM F 1344, for solid color homogeneous tiles and for through-mottled tiles as applicable.
11. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss < 0.70.
12. Hardness ASTM D 2240, Shore A, > 85.
13. Slip Resistance: Static coefficient of friction (James Test): ASTM D 2047, equal to or greater than > 0.5.
14. Asbestos-Free: Products shall contain no asbestos.
15. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result > 0.45 watts per square centimeter, Class 1.
16. Smoke Density: ASTM E 662, NFPA 258, NBS smoke density, < 450.
17. Color: As selected.
18. Static Load: Per ASTM F-970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be ? 0.005".

2.03 RESILIENT SHEET FLOORING

A. Rubber Sheet for Commercial Traffic:

1. Product Name: noraplan® environcare™, Article 1462, smooth surface.
 - a. Roll Size: 0.08 inches (2.0 mm) thickness, 49.2 feet by 48 inches (15.0 m by 1.22 m).
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
2. Product Name: noraplan® environcare™, Article 1463, smooth surface.
 - a. Roll Size: 0.12 inches (3.0 mm) thickness, 39.3 feet by 48 inches (12.0 m by 1.22 m).
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
3. Product Name: noraplan® logic, Article 1230, smooth surface.
 - a. Roll Size: 0.08 inches (2.0 mm) thickness, 49.2 feet by 48 inches (15.0 m by 1.22 m).
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
4. Product Name: noraplan® mega, Article 106, smooth surface.
 - a. Roll Size: 0.08 inches (2.0 mm) thickness, 49.2 feet by 48 inches (15.0 m by 1.22 m).
 - b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
5. Product Name: noraplan® mega, Article 1081, smooth surface.

- a. Roll Size: 0.12 inches (3.0 mm) thickness, 39.3 feet by 48 inches (12.0 m by 1.22 m).
- b. Material: nora® rubber Compound 913 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
6. Back of Tile: Smooth, double-sanded back.
7. Limited Wear Warranty: 5 years.
8. Standard: ASTM F 1344, for solid color homogeneous tiles and for through-mottled tiles as applicable.
9. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss not greater than < 0.70.
10. Hardness: ASTM D 2240, Shore A, not less than > 85.
11. Slip Resistance: Static coefficient of friction (James Test): ASTM D 2047, equal to or greater than > 0.5.
12. Asbestos-Free: Products shall contain no asbestos.
13. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result to be not less than > 0.45 watts per square centimeter, Class 1.
14. Smoke Density: ASTM E 662, NFPA 258, NBS smoke density, less than < 450.
15. Burn Resistance: Cigarette and solder burn resistance.
16. Halogen-Free: Products shall contain no halogens.
17. PVC-Free: Products shall contain no poly-vinyl-chloride.
18. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
19. Color: As selected.
20. Static Load: Per ASTM F-970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be ? 0.005".
21. Product Name: noraplan® uni, Article 2461, smooth surface.
 - a. Material: nora® rubber Compound 916 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.
 - b. Tile Size: 0.08 inches (2.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm)
22. Back of Tile: Smooth, double-sanded back.
23. Limited Wear Warranty: 5 years.
24. Standard: ASTM F 1344, for solid color homogeneous tiles and for through-mottled tiles as applicable.
25. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss < 0.70.
26. Hardness: ASTM D 2240, Shore A, < 85.
27. Slip Resistance: Static coefficient of friction (James Test): ASTM D 2047, equal to or greater than 0.5.
28. Asbestos-Free: Products shall contain no asbestos.
29. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result < 0.45 watts per square centimeter, Class 1.
30. Smoke Density: ASTM E 662, NFPA 258, NBS smoke density, less than 450.
31. Bacteria Resistance: Products shall be resistant to bacteria, fungi, and micro-organism activity, according to ASTM E 2180 and ASTM G 21.
32. Burn Resistance: Cigarette and solder burn resistance.
33. Halogen-Free: Products shall contain no halogens.
34. PVC-Free: Products shall contain no poly-vinyl-chloride.
35. IAQ: Product shall meet GreenGuard requirements.
36. CA 01350: Product shall meet CA 01350 specification requirements.
37. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
38. Color: As selected.
39. Static Load: Per ASTM F-970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be ? 0.005".
40. Product Name: noraplan® eco, Article 2082, smooth surface.
 - a. Tile Size: 0.08 inches (2.0 mm) thickness, 24 inches by 24 inches (61 cm by 61 cm)
 - b. Material: nora® rubber Compound 910 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 20%.

41. Back of Tile: Smooth, double-sanded back.
42. Limited Wear Warranty: 5 years.
43. Standard: ASTM F 1344, for solid color homogeneous tiles and for through-mottled tiles as applicable.
44. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss < 0.70.
45. Hardness: ASTM D 2240, Shore A, > 85.
46. Slip Resistance: Static coefficient of friction (James Test): ASTM D 2047, > 0.5.
47. Asbestos-Free: Products shall contain no asbestos.
48. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result > 0.45 watts per square centimeter, Class 1.
49. Smoke Density: ASTM E 662, NFPA 258, NBS smoke density, < 450.
50. Burn Resistance: Cigarette and solder burn resistance.
51. Halogen-Free: Products shall contain no halogens.
52. PVC-Free: Products shall contain no poly-vinyl-chloride.
53. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
54. Color: As selected.
55. Static Load: Per ASTM F-970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be ? 0.005".

B. Rubber Sheet for Commercial Traffic with Acoustic Backing:

1. Product Name: noraplan® environcare™ acoustic, Article 1420, smooth surface, (seams shall be welded).
 - a. Roll Size: 0.16 inches (4.0 mm) thickness, 0.06 inches (1.6 mm) rubber top layer, 2.4 mm (0.10 inches) rubber foam backing, 39.3 feet by 48 inches (12.0 m by 1.22 m).
 - b. Material: nora® rubber Compound 915 with abundant natural fillers and environmentally compatible color pigments with rubber foam backing. Rubber content approximately 31%.
2. Limited Wear Warranty: 5 years.
3. Standard: ASTM F 1859 rubber sheet floor covering with backing.
4. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss < 0.70.
5. Hardness: ASTM D 2240, Shore A, > 85.
6. Slip Resistance: Static coefficient of friction (James Test): ASTM D 2047, > 0.5.
7. Asbestos-Free: Products shall contain no asbestos.
8. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result > 0.45 watts per square centimeter, Class 1.
9. Smoke Density: ASTM E 662, NFPA 258, NBS smoke density, < 450.
10. Bacteria Resistance: Products shall be resistant to bacteria, fungi, and micro-organism activity, according to ASTM E 2180 and ASTM G 21.
11. Burn Resistance: Cigarette and solder burn resistance.
12. Halogen-Free: Products shall contain no halogens.
13. PVC-Free: Products shall contain no poly-vinyl-chloride.
14. IAQ: Products shall meet GreenGuard requirements.
15. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
16. Color: As selected.
17. Static Load: Per ASTM F 970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be ? 0.005".
18. Acoustic Rating: EN 140-8 = 20 dB, ASTM E 989 Class (IIC) = 55.

2.04 RESILIENT STAIRTREADS (ACCORDING TO ASTM F 2169) AND NOSING'S

A. One-Piece Nosing, Tread, and Riser:

1. Product Name: norament® grano stairtreads, Article's 479 (4 ft), 468 (5ft), 469 (6ft), hammered surface (smooth riser), grano design.
 - a. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.

- b. Tread Size: 0.2 inches (5 mm) overall thickness, standard width's 4, 5 and 6 ft.
 2. Product Name: norament® stairtreads (hammered), Article's 479 (4 ft), 468 (5ft), 469 (6ft), hammered surface (smooth riser).
 - a. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 - b. Tread Size: 0.2 inches (5 mm) overall thickness, standard width's 4, 5 and 6 ft.
 3. Product Name: norament® stairtreads (round), Article's 465 (4 ft), 466 (5ft), 467 (6ft), raised round pastilles (smooth riser).
 - a. Material: nora® rubber Compound 925 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 - b. Tread Size: 0.18 inches (4.5 mm) overall thickness, 0.02 inches (0.5 mm) raised pattern thickness, standard width's 4, 5 and 6 ft.
 4. Back of Tile: Smooth, double-sanded back.
 5. Limited Wear Warranty: 10 years.
 6. Standard: ASTM F 1344, for solid color homogeneous tiles and through-mottled tiles as applicable.
 7. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss not greater than < 0.60.
 8. Hardness: ASTM D 2240, Shore A, not less than > 85.
 9. Slip Resistance: Static coefficient of friction (James Test), ASTM D 2047, equal to or greater than > 0.5.
 10. Asbestos-Free: Products shall contain no asbestos.
 11. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result to be not less than > 0.45 watts per square centimeter, Class 1.
 12. Smoke Density: ASTM E 662, NFPA 258, NBS smoke density, less than < 450.
 13. Bacteria Resistance: Products shall be resistant to bacteria, fungi, and micro-organism activity, according to ASTM E 2180 and ASTM G 21.
 14. Burn Resistance: Cigarette and solder burn resistance.
 15. Halogen-Free: Products shall contain no halogens.
 16. PVC-Free: Products shall contain no poly-vinyl-chloride.
 17. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
 18. Color: As selected.
 19. Static Load: Per ASTM F-970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be ? 0.005".
 20. Shine Cleaning Products shall have a gloss value no greater than < 30 units. Floor surfaces shall be easily cleaned and not require coatings and stripping or the use of chemicals that may be hazardous to human health. Products shall be free of teratogenic, mutagenic or anything known to be carcinogenic.
- B. One-Piece Nosing, Tread, and Riser:
 1. Product Name: norament® 926 xi stairtreads, Article 465, raised round pastilles (smooth riser).
 - a. Material: nora® rubber Compound 926 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 40%.
 - b. Tread Size: 0.18 inches (4.5 mm) overall thickness, 0.02 inches (0.5 mm) raised pattern thickness, standard width 4 ft.
 2. Back of Tile: Smooth, double-sanded back.
 3. Limited Wear Warranty: 10 years.
 4. Standard: ASTM F 1344, for solid color homogeneous tiles.
 5. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss not greater than .60.
 6. Hardness: ASTM D 2240, Shore A, equal to or greater than 80.
 7. Slip Resistance: Static coefficient of friction (James Test): ASTM D 2047, > 0.5.
 8. Asbestos-Free: Products shall contain no asbestos.
 9. Flammability: ASTM E 648; NFPA 253; NBSIR 75 950 result > 0.45 watts per square centimeter, Class 1.
 10. Smoke Density: ASTM E 662, NFPA 258, NBS smoke density, < 450.

11. Bacteria Resistance: Products shall be resistant to bacteria, fungi, and micro-organism activity, according to ASTM E 2180 and ASTM G 21.
 12. Burn Resistance: Cigarette and solder burn resistance.
 13. Halogen-Free: Products shall contain no halogens.
 14. PVC-Free: Products shall contain no poly-vinyl-chloride.
 15. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
 16. Color: As selected.
 17. Static Load: Per ASTM F 970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be $\leq 0.005"$.
- C. One-Piece Nosing, Tread, and Riser:
1. Product Name: norament® 920 stairtreads, Article 354, raised round pastilles (smooth riser).
 - a. Material: nora® rubber Compound 920 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 46%.
 - b. Tread Size: 0.18 inches (4.5 mm) overall thickness, 0.02 inches (0.5 mm) raised pattern thickness, standard width 4 ft.
 2. Back of Tile: Smooth, double-sanded back.
 3. Limited Wear Warranty: 10 years.
 4. Standard: ASTM F 1344, for solid color homogeneous tiles.
 5. Abrasion Resistance: Taber abrasion test, ASTM D 3389, H-18 wheel, 500 gram load, 1000 cycles, gram weight loss < 0.60 .
 6. Hardness: ASTM D 2240, Shore A, > 85 .
 7. Slip Resistance: Static coefficient of friction (James Test): ASTM D 2047, > 0.5 .
 8. Asbestos-Free: Products shall contain no asbestos.
 9. Flammability: ASTM E 84, Class A.
 10. Smoke Density: ASTM E 84, Class A.
 11. Bacteria Resistance: Products shall be resistant to bacteria, fungi, and micro-organism activity, according to ASTM E 2180 and ASTM G 21.
 12. Burn Resistance: Cigarette and solder burn resistance.
 13. Halogen-Free: Products shall contain no halogens.
 14. PVC-Free: Products shall contain no poly-vinyl-chloride.
 15. ISO 14001: Manufacturer shall be ISO 14001 Environmental Management Systems Certified
 16. Color: As selected.
 17. Static Load: Per ASTM F 970 Standard Test Method for Static Load Limit, residual compression, when tested with 800 lbs results shall be $\leq 0.005"$.
- D. Stair Nosing's
1. Stair Nosing's: nora® T 5049 A/C, for flooring 0.8 inches (2mm) to 0.11 inches (2.7mm).
 - a. nora® T 5049 E/F, for flooring 0.14 inches (3.5mm) to 0.16 inches (4mm).
 - b. nora® T5044 A/C, for flooring 0.8 inches (2mm) to 0.11 inches (2.7mm).
 - c. nora® T5044 E/F for flooring 0.14 inches (3.5mm) to 0.16 inches (4mm).
 - 1) Material: nora® rubber Compound 961 with abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 38%.

2.05 RESILIENT WALL BASE / ACCESSORIES

- A. Rubber Wall Base / Coving:
1. Wall Base: nora® wall base Article 820, 0.125 inches (3.175 mm) thick, 4 inches (102 mm) high, 120 feet (36.5 m) rolls
 - a. Standard: nora® rubber Compound 999, ASTM F 1861, Type TP - rubber, thermoplastic. With abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 38%.
 - b. Limited Wear Warranty: Five (5) years
 2. Sanitary Wall Base: nora® Sanitary wall base Article 817, , top leg 0.12 Inches (3 mm) thick, 5.98 inches (152 mm) high; connection dimension bottom leg 0.13 inches (3.2 mm) thick, 2.0 inches (50 mm) long. Available in 32.8 ft (10m)

- a. Standard: nora® rubber Compound 959, ASTM F 1861 Type TP - rubber, thermoplastic. With abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 38%.
 - 3. Limited Wear Warranty: Five (5) years
- B. Rubber Accessories:
 - 1. Cove Stick: nora® cove stick Article H 9010,
 - a. Standard: nora® rubber Compound 959, ASTM F 1861 Type TP - rubber, thermoplastic. With abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 38%.
 - b. Limited Wear Warranty: Five (5) years
 - 2. Banister trim: nora® Banister trim Article A 5013 U, 8.2 ft (2.5m) length.
 - a. Material: nora® rubber Compound 959 ASTM F 1861 Type TP - rubber, thermoplastic. With abundant natural fillers and environmentally compatible color pigments. Rubber content approximately 38%.
 - b. Limited Wear Warranty: Five (5) years

PART 3 - RESPONSIBILITES

3.01 The General Contractor shall provide the following

- A. A building or required area that is fully enclosed from the elements, roof, windows and doors shall all be finished and water tight.
- B. A concrete substrate that fully conforms to the requirements of ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- C. Concrete substrate that shall be structurally sound, finished shrinking, cracking, curling or moving.
- D. For all concrete substrates on or below grade a permanent effective vapor retarder with a low permeance (less than 0.1) having a minimum thickness of 10 mils, or meets the requirements of the latest edition of ASTM E 1745 (Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs) shall be placed directly underneath the concrete above the granular fill and shall be installed as per the manufacturer's written instructions. A letter shall be provided to the end user, confirming the correct products have been used and that it is fully warranted.
- E. A non-burnished concrete surface free from any paint, wax, oil, grease, film forming curing compounds, silicate penetrating curing compounds, sealing, hardening or parting compounds. The surface should not have any alkaline salts, laitance, mold, mildew, residual adhesive, adhesive removers or anything that may prevent adhesive / smoothing compound bonding. If surface is not free of the previous contaminates, then the general contractor should provide the mechanical means to remove them, this could be Blastrac, diamond grinding or similar with a vacuum attachment.
- F. To test and, or provide valid, acceptable, test results to the end user, of the moisture content of the subfloor, prior to flooring installation, when tested as per ASTM F 2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes. (results shall be <75% Relative Humidity), or go to 3.01 H.
- G. As an alternative to using ASTM F 2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes, ASTM F2420 - Standard Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood, however, it should be noted that with this method, results shall be <70% relative humidity.
- H. If it is not possible to provide a concrete substrate with a moisture level <75% Relative Humidity, then an effective surface Moisture Suppression System shall be used. (See Section: 3.02.F). Note: This should be quoted and planned for, but only used if necessary.

- I. A secure storage area that is maintained permanently or temporarily at service temperature and humidity, or $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ and 50% relative humidity for at least 48 hours prior to and during the application of the flooring, so the flooring contractor can acclimate the flooring materials.
- J. An installation area that is maintained permanently or temporarily at service temperature and humidity, or $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ and 50% relative humidity for at least 48 hours prior to, during and 72 hours after the application of the flooring.
- K. Areas of the flooring that are subject to direct sunlight through doors or windows shall have the doors or windows covered using blinds, curtains, cardboard or similar for the time of the installation and 72 hours after the installation to allow the adhesive to cure.
- L. If required, protect completed work from damage and construction operations using Masonite hardwood/plywood or similar (refer to nora® Tech 156, available upon request) and inspect immediately before final acceptance of project.
- M. Clean flooring surfaces only after adhesive has fully cured, no sooner than 72 hours after installation, unless agreed with nora® representative. Clean surfaces using non-abrasive materials and methods recommended by manufacturer's maintenance guide.

3.02 The Flooring Contractor shall provide the following:

- A. Installer shall be approved by nora systems, Inc. for the requirements of the project or INSTALL (International Standards & Training Alliance) resilient, approved or certified for the requirements of the project.
- B. An effective project manager, to manage the installers, and ensure that all of the required procedures are followed, documented and that the installation guides are followed.
- C. Acclimate the flooring in the provided secure storage area that is maintained permanently or temporarily at service temperature and humidity or $68^{\circ}\text{F} \pm 5^{\circ}\text{F}$ and 50% relative humidity for at least 48 hours prior to and during the application of the flooring.
- D. Perform Adhesive bond test in each major area (1 per 1,000 sq. ft.), a detailed method statement (nora® Tech 103) is available from nora systems, Inc., upon request. Examine after 72 hours to determine whether the bond is good to the substrate, if the preparation is sufficient or to look for signs of moisture. Do not proceed with the installation until all the results of the bond test are acceptable.
- E. Clean out and fill or repair any saw cuts and cracks following the written instructions from the manufacturer of the surface Moisture Suppression System (if used) or the smoothing compound manufacturer. NOTE: Do not install over any expansion joint, these shall be mirrored through to the surface using a suitable expansion joint cover.
- F. When required, use a suitable surface Moisture Suppression System that is fully warranted by the Suppression System manufacturer to perform under the given conditions (moisture content, presence of vapor retarder, surface profile and presence of any known contaminants within the concrete) for the same warranty time period as the flooring supplied. The Suppression System manufacturer shall provide written confirmation that the subfloor was prepared correctly prior to the installation of their product.
- G. Provide written confirmation that any surface Moisture Suppression System used, has been applied as instructed by the Suppression System manufacturer including the required mils thickness, or confirm the amount of gallons used per square footage, and that the workmanship is fully warranted. Perform and confirm results of any testing required by the Suppression Mitigation System's manufacturer.

- H. If required, use a suitable fully warranted smoothing compound that shall have a minimum compressive strength of 3000 psi (per ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring) at the time the flooring will be used (heavy traffic), follow the manufacturer's written installation instructions, including removal of old adhesives (do not use chemical adhesive removers, use the RFCI wet scraping method), curing compounds, or any potential bond breakers and confirm any necessary surface profile, also to follow any requirement to prime the subfloor prior to smoothing, the recommended minimum and maximum thickness shall be followed.
- I. If smoothing compound is used, provide written confirmation that the smoothing compound has been mixed and applied to the required smoothness and or levelness of the general contractor / end user, or ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring, following the manufacturer's written instructions and that the workmanship is fully warranted.
- J. Vacuum floors immediately prior to installing the flooring to remove all loose particles. If required, use only water based sweeping compounds, do not use wax or oil based compounds that leave behind a residue that may interfere with the adhesive bond.
- K. Install resilient flooring in accordance with manufacturer's installation guides, including the following:
 - 1. Do not mix manufacturing batches of a color within the same area.
 - 2. Do not install resilient flooring over building expansion joints.
 - 3. Do not install defective or damaged resilient flooring.
 - 4. Layout resilient flooring to provide equal size at perimeter. Adjust layout as necessary to reduce the amount of resilient flooring which is cut to less than half full width.
 - 5. Lay resilient flooring with arrows in the same direction (excluding borders).
 - 6. Install resilient flooring without voids at seams. Lay seams together without stress.
 - 7. Cut/scribe resilient flooring neatly at perimeter and obstructions.
 - 8. Extend resilient flooring into reveals, closets, and similar openings.
 - 9. Remove excess adhesive immediately.
 - 10. Install reducer strips at exposed edges.
- L. Install nora® wallbase in accordance with manufacturer's installation guide. Install in longest practical lengths.
- M. Install resilient stairtreads and accessories in accordance with manufacturer's installation guide. Install reducer strips at exposed edges.
- N. noraplan® SEAMLESS FLOORING INSTALLATION (when required). Rout seams and heat weld together with coordinated colored heat welding rod or cold weld with coordinated colored cold weld compound in accordance with resilient flooring manufacturer's installation guide.
- O. norament® SEAMLESS FLOORING INSTALLATION (when required). Rout seams and weld together with coordinated colored cold weld compound in accordance with resilient flooring manufacturer's installation guides.
- P. FLASH COVING OF SHEET GOOD (when required). Extend flooring up the wall in a flash-coved method, with resilient flooring manufacturer's recommendations, to a height as required. Provide cove stick and suitable capping strip. All vertical and external seams shall be cold welded with coordinated colored cold weld compound. Follow resilient flooring manufacturer's installation guide.
- Q. SANITARY BASE (when required). All seams between sanitary base and flooring and all mitered seams shall be cold welded together with coordinated colored cold weld compound in accordance with resilient flooring manufacturer's installation guide.
- R. Touch-up and repair minor damage to eliminate all evidence of repair. Remove and replace work which cannot be satisfactorily repaired.

3.03 The Manufacturer shall provide the following:

- A. Provide a one-year warranty against defects in manufacturing of all products supplied. Provide limited wear warranty for the flooring supplied, as detailed per product.

- B. The manufacturer shall have the Quality Management System approved by Lloyd's Register Quality Assurance to the Quality Management System Standard ISO 9001:2000.
- C. Manufacturer shall be ISO 14001 Environmental Management Systems Certified.
- D. Flooring that shall contain no poly-vinyl-chloride.
- E. Flooring that shall contain no halogens.
- F. Flooring that shall contain no asbestos
- G. Training for the installers, at nora® Training Academy. Contact the nora® Technical Department for details.
- H. Flooring that shall have a gloss value no greater than > 30 units.
- I. Floor surfaces shall be easily cleaned and not require coatings and stripping, or use chemicals that may be hazardous to human health.
- J. Products shall be free of teratogenic, mutagenic or anything known to be carcinogenic.

END OF SECTION

SECTION 09685**CARPET TILE****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Carpet tile, fully adhered.

1.02 RELATED REQUIREMENTS

- A. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 01732 - Waste Management: Reclamation/Recycling of new carpet tile scrap.
- C. Section 03300 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors.

1.03 REFERENCE STANDARDS

- A. CRI 104 - Standard for Installation of Commercial Textile Floorcovering Materials; Carpet and Rug Institute; 2002.
- B. CRI (GLA) - Green Label Testing Program - Approved Adhesive Products; Carpet and Rug Institute; current listings at www.carpet-rug.org.
- C. CRI (GLC) - Green Label Testing Program - Approved Product Categories for Carpet; Carpet and Rug Institute; current listings at www.carpet-rug.org.
- D. CRI (GLP) - Green Label Plus Carpet Testing Program - Approved Products; Carpet and Rug Institute; current listings at www.carpet-rug.org.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- D. LEED Report: Submit data documenting VOC content of carpet tile and adhesives; copy of current CRI Approved Products Listing is acceptable.
- E. Manufacturer's Installation Instructions: Indicate special procedures.
- F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01600 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing carpet with minimum 3 years experience.

1.06 FIELD CONDITIONS**PART 2 PRODUCTS****2.01 MANUFACTURERS**

- A. J+J Invision; Product Problem Solved Modulare.

2.02 MATERIALS

- A. Carpet Tile: Tufted, manufactured in one color dye lot.
 - 1. Tile Size: 24_x_24 inch, nominal.
 - 2. Color: to be selected by Architect.
 - 3. VOC Content: Provide CRI Green Label Plus certified product; in lieu of labeling, independent test report showing compliance is acceptable.
 - 4. Secondary Backing Material: Nexus Modular.
 - 5. Total Weight: 22 oz/sq yd.

2.03 ACCESSORIES

- A. Edge Strips: Embossed aluminum, color as selected.
- B. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC of 50 g/L; CRI Green Label certified; in lieu of labeled product, independent test report showing compliance is acceptable.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
- C. Verify that concrete sub-floor surfaces are dry enough and ready for flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F 710; obtain instructions if test results are not within limits recommended by carpet tile manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
- B. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions and CRI 104.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Fully adhere carpet tile to substrate.
- G. Trim carpet tile neatly at walls and around interruptions.
- H. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 09900**PAINTS AND COATINGS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Surface preparation.
- B. Field application of paints, stains, varnishes, and other coatings.
- C. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Elevator pit ladders.
 - 3. Exposed surfaces of steel lintels and ledge angles.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Non-metallic roofing and flashing.
 - 6. Stainless steel, anodized aluminum, bronze, terne, and lead items.
 - 7. Marble, granite, slate, and other natural stones.
 - 8. Floors, unless specifically so indicated.
 - 9. Ceramic and other tiles.
 - 10. Brick, architectural concrete, cast stone.
 - 11. Glass.
 - 12. Concrete masonry in utility, mechanical, and electrical spaces.
 - 13. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Section 01355 - LEED Certification Procedures: LEED rating system definition.
- B. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 02765 - Pavement Markings: Painted pavement markings.
- D. Section 05510 - Metal Stairs: Shop-primed items.
- E. Section 09960 - High-Performance Coatings.
- F. Section 13915 - Identification for Fire Suppression Piping and Equipment: Painted identification.
- G. Section 13915 - Identification for Fire Suppression Piping and Equipment: Color coding scheme for items to be painted under this section.

1.03 DEFINITIONS

- A. Conform to ASTM D 16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- A. ASTM D 16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2007.
- B. ASTM D 4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 1992 (Reapproved 2003).
- C. GreenSeal GS-11 - Paints; 1993.

- D. USGBC LEED-NC - LEED Green Building Rating System for New Construction and Major Renovations; U.S. Green Building Council; Version 2.2, 2005.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on all finishing products, including VOC content.
- C. Samples: Submit two paper chip samples, 3 x 3 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.
- D. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.
- E. LEED Report: VOC content of all interior opaque coatings actually used.
- F. Manufacturer's Instructions: Indicate special surface preparation procedures.
- G. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01600 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Coatings: 1 gallon of each color; store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.

1.06 MOCK-UP

- A. See Section 01400 - Quality Requirements, for general requirements for mock-up.
- B. Provide panel, 12" long by 12" wide, illustrating special coating color, texture, and finish.
- C. Provide door and frame assembly illustrating paint coating color, texture, and finish.
- D. Locate where directed.
- E. Mock-up may remain as part of the work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
- B. Paints:
 - 1. Sherwin Williams: www.sherwin-williams.com.

2. Duron, Inc: www.duron.com.
3. ICI Paints: www.icipaintsinna.com.
4. Benjamin Moore & Co: www.benjaminmoore.com.
5. PPG Architectural Finishes, Inc: www.ppgaf.com.
6. Pratt & Lambert Paints: www.prattandlambert.com.

C. Substitutions: See Section 01600 - Product Requirements.

2.02 PAINTS AND COATINGS - GENERAL

- A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 2. Supply each coating material in quantity required to complete entire project's work from a single production run.
 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Volatile Organic Compound (VOC) Content: Comply with Section 01616.
- D. Colors: To be selected from manufacturer's full range of available colors.
 1. Selection to be made by Architect after award of contract.
 2. Extend colors to surface edges; colors may change at any edge as directed by Architect.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Paint CE-OP-3L - Masonry/Concrete, Opaque, Latex, 3 Coat:
 1. 1 coat Sherwin Williams Loxon Acrylic Primer
 2. ; SherLastic elastomeric coating, 2 coats or as per Manufacturer's instructions.
- B. Paint ME-OP-3L - Ferrous Metals, Unprimed, Latex, 3 Coat:
 1. One coat of latex primer.
 2. Semi-gloss: Two coats of latex enamel; _____.
- C. Paint ME-OP-2L - Ferrous Metals, Primed, Latex, 2 Coat:
 1. Touch-up with rust-inhibitive primer recommended by top coat manufacturer.
 2. Semi-gloss: Two coats of latex enamel; _____.

2.04 PAINT SYSTEMS - INTERIOR

- A. Paint WI-OP-3L - Wood, Opaque, Latex, 3 Coat:
 1. One coat of latex primer sealer.
 2. Semi-gloss: Two coats of latex enamel; _____.
- B. Paint WI-TR-V - Wood, Transparent, Varnish, No Stain:
 1. One coat sealer.
 2. Satin: One coat of varnish; _____.
- C. Paint MI-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:
 1. One coat of alkyd primer.
 2. Gloss: Two coats of alkyd enamel; _____.
- D. Paint MI-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat:
 1. Touch-up with alkyd primer.
 2. Semi-gloss: Two coats of alkyd enamel; _____.
- E. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
 1. One coat of alkyd primer sealer.

2. Semi-gloss: Two coats of latex enamel; _____.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.
- D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 1. Gypsum Wallboard: 12 percent.
 2. Plaster and Stucco: 12 percent.
 3. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 4. Interior Wood: 15 percent, measured in accordance with ASTM D 4442.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to coating application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.
- G. Plaster Surfaces to be Painted: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- H. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- I. Corroded Steel and Iron Surfaces to be Painted: Prepare using at least SSPC-PC 2 (hand tool cleaning) or SSPC-SP 3 (power tool cleaning) followed by SSPC-SP 1 (solvent cleaning).
- J. Uncorroded Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand or power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

- K. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
- L. Interior Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- M. Interior Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.
- N. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance.
- D. Sand wood and metal surfaces lightly between coats to achieve required finish.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- G. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

- A. See Section 01400 - Quality Requirements, for general requirements for field inspection.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finished coatings until completion of project.
- B. Touch-up damaged coatings after Substantial Completion.

END OF SECTION

SECTION 09960**HIGH-PERFORMANCE COATINGS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. High performance coatings.
- B. Special preparation of surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 01616 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 09900 - Paints and Coatings.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating coating materials.
- C. Samples: Submit two samples 3x3__ inch in size illustrating colors available for selection.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include cleaning procedures and repair and patching techniques.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Coating Materials: 1 gallon of each type and color.
 - 2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.04 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document that applies to application on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.

1.05 MOCK-UP

- A. Provide mock-up, 2 feet long by 2 feet wide, illustrating coating, for each specified coating.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

1.06 FIELD CONDITIONS

- A. Do not install materials when temperature is below 55 degrees F or above 90 degrees F.
- B. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- C. Restrict traffic from area where coating is being applied or is curing.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. High-Performance Coatings:
 - 1. Hydro Stop; Product Flex Coat. www.hydro-stop.com
 - 2. Substitutions: Section 01600 - Product Requirements.

2.02 MATERIALS

- A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.
 - 1. Maximum volatile organic compound (VOC) content: As required by applicable regulations.
 - 2. Colors: Selected from manufacturer's standard colors.
- B. Primers: As recommended by coating manufacturer for specific substrate, unless otherwise specified.
- C. Shellac: Pure, white type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.

3.02 PREPARATION

- A. Clean surfaces of loose foreign matter.
- B. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.
- C. Remove finish hardware, fixture covers, and accessories and store.
- D. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.03 PRIMING

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.04 COATING APPLICATION

- A. Apply coatings in accordance with manufacturer's instructions, to thicknesses specified.
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

- A. Protect finished work from damage.

END OF SECTION

SECTION 10160**METAL TOILET COMPARTMENTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Metal toilet compartments.
- B. Urinal screens.

1.02 RELATED REQUIREMENTS

- A. Section 10800 - Toilet, Bath, and Laundry Accessories.

1.03 REFERENCE STANDARDS

- A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- C. Product Data: Provide data on panel construction, hardware, and accessories.
- D. Samples: Submit two samples of partition panels, ____x____ inch in size illustrating panel finish, color, and sheen.
- E. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Metal Toilet Compartments:
 - 1. General Partitions Mfg. Corp: www.generalpartitions.com.
 - 2. Global Steel Products Corp: www.globalpartitions.com.
 - 3. Metpar Corp: www.metpar.com.
 - 4. Substitutions: Section 01600 - Product Requirements.

2.02 MATERIALS

- A. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M, with G90/Z275 coating.

2.03 COMPONENTS

- A. Toilet Compartments: Stainless steel, floor-mounted headrail-braced.
- B. Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound deadening core, formed and closed edges; corners made with corner clips or mitered, welded, and ground smooth.
 - 1. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C. Door and Panel Dimensions:
 - 1. Thickness: 1 inch.
 - 2. Door Width: 24 inch.
 - 3. Door Width for Handicapped Use: 36 inch, out-swinging.

- D. Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.
- E. Urinal Screens: Wall mounted with two panel brackets, and floor-to-ceiling vertical upright consisting of pilaster anchored to floor and ceiling.
- F. Urinal Screen Splash Panels: Stainless steel sheet 30 inch wide x 42 inch high mounted on partitions adjacent to urinals. Fasten with stainless steel screws spaced 8 inches on center.

2.04 ACCESSORIES

- A. Pilaster Shoes: Formed chromed steel with satin finish, 3 inch high, concealing floor fastenings.
 - 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
 - 2. Provide ceiling attachment using two adjustable hanging studs, attached to above-ceiling framing.
- B. Brackets: Polished chrome-plated non-ferrous cast metal.
- C. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
 - 1. For attaching panels and pilasters to brackets: Through-bolts and nuts; tamper proof.
- D. Hardware: Polished chrome plated non-ferrous cast metal:
 - 1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 - 2. Thumb turn or sliding door latch with exterior emergency access feature.
 - 3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 - 4. Coat hook with rubber bumper; one per compartment, mounted on door.
 - 5. Provide door pull for outswinging doors.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that field measurements are as indicated.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.03 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.

END OF SECTION

SECTION 10260**WALL AND CORNER GUARDS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Corner guards.

PART 2 PRODUCTS**2.01 COMPONENTS**

- A. Corner Guard - Surface Mounted: High impact vinyl with extruded aluminum full height retainer and integral impact absorbing device.
 - 1. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
 - 2. Size: 2 inches.
 - 3. Corner: Square.
 - 4. Color: As selected from manufacturer's standard colors.
 - 5. Length: One piece.
 - 6. Preformed end caps.
- B. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.

2.02 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on Drawings.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.
- B. Position corner guard ____ inches above finished floor to ____ inches high.

3.03 TOLERANCES

END OF SECTION

SECTION 10400**IDENTIFICATION DEVICES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Room and door signs.
- B. Interior directional and informational signs.
- C. Emergency evacuation maps.
- D. Building identification signs.
- E. Three Dimensional exterior building sign

1.02 REFERENCE STANDARDS

- A. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.
- B. ATBCB ADAAG - Americans with Disabilities Act Accessibility Guidelines; 2002.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
 - 1. When room numbers to appear on signs differ from those on the drawings, include the drawing room number on schedule.
 - 2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
 - 3. Submit for approval by Owner through Architect prior to fabrication.
- D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
- E. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
- F. Verification Samples: Submit samples showing colors specified.
- G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.

PART 2 PRODUCTS**2.01 SIGNAGE APPLICATIONS**

- A. Accessibility Compliance: All signs are required to comply with ADAAG and ANSI/ICC A 117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

- B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
 - 1. Sign Type: Flat signs with engraved panel media as specified.
 - 2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.
 - 3. Character Height: 1 inch.
 - 4. Sign Height: 2 inches, unless otherwise indicated.
 - 5. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", room numbers shown on the drawings, and braille.
- C. Interior Directional and Informational Signs:
 - 1. Sign Type: Same as room and door signs.
- D. Emergency Evacuation Maps:
 - 1. Allow for one map per elevator lobby.
 - 2. Map content to be provided by Owner.
 - 3. Use clear plastic panel silk-screened on reverse, in brushed aluminum frame, screw-mounted.
- E. Building Identification Signs:
 - 1. Use individual metal letters.
 - 2. Mount on outside wall in location shown on drawings.

2.02 SIGN TYPES

- A. Flat Signs: Signage media without frame.
 - 1. Edges: Square.
 - 2. Corners: Square.
 - 3. Wall Mounting of One-Sided Signs: Tape adhesive.
- B. Color and Font: Unless otherwise indicated:
 - 1. Character Font: Helvetica, Arial, or other sans serif font.
 - 2. Character Case: Upper case only.
 - 3. Background Color: Clear.
 - 4. Character Color: Contrasting color.

2.03 DIMENSIONAL LETTERS

- A. Metal Letters:
 - 1. Mounting: Tape adhesive.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Locate signs where indicated:
 - 1. Room and Door Signs: Locate on wall at latch side of door with centerline of sign at 60 inches above finished floor.
 - 2. If no location is indicated obtain Owner's instructions.
- D. Protect from damage until Substantial Completion; repair or replace damage items.

END OF SECTION

SECTION 10523**FIRE EXTINGUISHERS, CABINETS AND ACCESSORIES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.

1.02 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers; National Fire Protection Association; 2007.
- B. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate cabinet physical dimensions.
- C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Fire Extinguishers, Cabinets and Accessories:
 - 1. JL Industries, Inc: www.jlindustries.com.
 - 2. Larsen's Manufacturing Co: www.larsensmfg.com.
 - 3. Potter-Roemer: www.potterroemer.com.
 - 4. Substitutions: See Section 01600 - Product Requirements.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by Underwriters Laboratories Inc. for the purpose specified and indicated.

2.03 FIRE EXTINGUISHER CABINETS

- A. Cabinet Configuration: Recessed type.
 - 1. Sized to accommodate accessories.
 - 2. Trim: Flat, 1 inch wide face.
- B. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.
- C. Door Glazing: Plastic, clear, 1/8 inch thick acrylic. Set in resilient channel gasket glazing.
- D. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.
- E. Weld, fill, and grind components smooth.
- F. Finish of Cabinet Exterior Trim and Door: Satin chrome.

2.04 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.
- B. Extinguisher Theft Alarm: Battery operated alarm, 10 second delay for disarming, activated by opening cabinet door.
- C. Graphic Identification:.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure rigidly in place.
- C. Place extinguishers and accessories in cabinets.

END OF SECTION

SECTION 10800**TOILET, BATH, AND LAUNDRY ACCESSORIES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Accessories for toilet rooms and utility rooms.
- B. Grab bars.

1.02 RELATED REQUIREMENTS

- A. Section 08830 - Mirrors: Other mirrors.
- B. Section 09300 - Tile: Ceramic washroom accessories.
- C. Section 10160 - Metal Toilet Compartments.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

- A. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.
- B. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Toilet Accessories:
 - 1. A & J Washroom Accessories Inc: www.ajwashroom.com.
 - 2. American Specialties, Inc: www.americanspecialties.com.
 - 3. Bradley Corporation: www.bradleycorp.com.
 - 4. GAMCO: www.gamcousa.com.
 - 5. Bobrick: www.bobrick.com
 - 6. Substitutions: Section 01600 - Product Requirements.
- B. All items of each type to be made by the same manufacturer.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- B. Keys: Provide 5 keys for each accessory to Owner; master key all lockable accessories.
- C. Mirror Glass: Float glass, ASTM C 1036 Type I, Class 1, Quality Q2, with silvering, copper coating, and suitable protective organic coating to copper backing in accordance with GSA CID A-A-3002.
- D. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof, security type.
- E. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 FINISHES

- A. Stainless Steel: No. 4 satin brushed finish, unless otherwise noted.
- B. Back paint components where contact is made with building finishes to prevent electrolysis.

2.04 TOILET ROOM ACCESSORIES

- A. Hand Dryers: Electric, recessed mounted
 - 1. Product: ExtremeAir HandDryer GXT-MR manufactured by GAMCO.
- B. Toilet Paper Dispenser: Double roll, surface mounted bracket type, stainless steel, spindleless type for tension spring delivery designed to prevent theft of tissue roll.
- C. Combination Towel Dispenser/Waste Receptacle: Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges, tumbler locks on upper and lower doors.
 - 1. Waste receptacle capacity: 4 gallons.
- D. Soap Dispenser: Liquid soap dispenser, deck-mounted on vanity, with polyethylene container concealed below deck; piston and 4 inch spout of stainless steel with bright polished finish; chrome-plated deck escutcheon.
- E. Mirrors: Stainless steel framed, 6 mm thick tempered glass mirror.
 - 1. Size: see drawings.
- F. Grab Bars: Stainless steel, 1-1/4 inches outside diameter, minimum 0.05 inch wall thickness, nonslip grasping surface finish, concealed flange mounting; 1-1/2 inches clearance between wall and inside of grab bar.
 - 1. Length and configuration: As indicated on drawings.
- G. Combination Sanitary Napkin/Tampon Dispenser: Stainless steel, recessed.
- H. Sanitary Napkin Disposal Unit: Stainless steel, back-to-back partition mounting with adjustable flanges, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.

2.05 UTILITY ROOM ACCESSORIES

- A. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, with 1/2 inch returned edges, 0.06 inch steel wall brackets.
 - 1. Product: US-1 Utility Shelf 30", 3 Holders, 2 Hooks manufactured by GAMCO.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights and Locations: As required by accessibility regulations and as indicated on drawings

END OF SECTION

SECTION 11161**DOCK LEVELERS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Prefabricated steel leveler.
- B. Operating hardware.

1.02 RELATED REQUIREMENTS

- A. Section 03100 - Concrete Forms and Accessories: Placement of leveler frame and safety lock frame into concrete loading dock.
- B. Section 03300 - Cast-in-Place Concrete: Concrete pit.
- C. Section 11165 - Dock Bumpers.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide materials and finish, installation details, roughing-in measurements, and operation of unit and safety lock device.
- C. Shop Drawings: Indicate required opening dimensions, tolerances of opening dimensions, placement dimensions of safety lock device, perimeter conditions of construction.
- D. Manufacturer's Installation Instructions: Indicate special requirements.
- E. Operation Data: Provide operating instructions, identify unit limitations.
- F. Maintenance Data: Provide unit maintenance information, lubrication cycles, spare parts manual.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Dock Levelers:
 - 1. Blue Giant Equipment Corporation: www.bluegiant.com.
 - 2. Kelly Company: www.kelleycompany.com.
 - 3. Rite-Hite Corp: www.ritehite.com.

2.02 COMPONENTS

- A. Dock Leveler:
 - 1. Operation: Manual.
 - 2. Deck Width: 72 inch.
 - 3. Deck Length: 48 inch.
- B. Deck: 1/4 inch steel checker plate deck, reinforced on underside, welded to fabricated steel frame; counter balanced with 16 inch long automatically operated plate lip; lip to lock in vertical position when leveler is at rest at dock level.
- C. Railing: Steel pipe of 1-1/2 inch diameter, with top rail, three intermediate horizontal rails, and uprights at 48 inches on center, maximum; threaded joints; steel anchor plates.
- D. Pit Frame: Steel angle, 3 x 3 x 1/4 inch; welded corners, fitted with anchors for concrete embedment.

2.03 ACCESSORIES

- A. Dock Bumpers: Specified in Section 11165.

2.04 FINISHES

- A. Leveler Platform: Hot dip galvanized to 1.25 oz/sq ft finish.
- B. Leveler Frame: Hot dip galvanized to 1.25 oz/sq ft finish.
- C. Railing: Hot dip galvanized to 1.25 oz/sq ft finish.
- D. Pit Frame: Hot dip galvanized to 1.25 oz/sq ft finish.
- E. Vehicle Restraint: Yellow painted hook, galvanized steel operating mechanism.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough-in openings are acceptable.

3.02 INSTALLATION

- A. Install dock leveler and mechanical safety vehicle lock unit in prepared opening in accordance with manufacturer's instructions.
- B. Set square and level.

3.03 ADJUSTING

- A. Adjust installed unit and safety device for smooth and balanced operation.

END OF SECTION

SECTION 11165**DOCK BUMPERS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Dock bumpers of reinforced rubber with attachment frame.

1.02 RELATED REQUIREMENTS

- A. Section 03100 - Concrete Forms and Accessories: Placement of bumper anchors into concrete.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate unit dimensions, method of anchorage, and details of construction.
- C. Manufacturer's Installation Instructions: Indicate special installation requirements.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Dock Bumpers:
 - 1. Blue Giant Equipment Corporation: www.bluegiant.com.
 - 2. Chalfant Sewing Fabricators, Inc.: www.chalfantusa.com.
 - 3. Durable Corp: www.durablecorp.com.
 - 4. Substitutions: See Section 01600 - Product Requirements.

2.02 COMPONENTS

- A. Bumpers: Fabric reinforced rubber pads, ozone resistant, laminated and compressed in position with two galvanized steel rods with threaded ends, washers and nuts; between 3 x 2-1/2 x 1/4 inch galvanized steel angle end plates:

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that anchor placement is acceptable.

3.02 INSTALLATION

- A. Install dock bumpers in accordance with manufacturer's instructions.
- B. Set plumb and level.

END OF SECTION

SECTION 11400**FOOD SERVICE EQUIPMENT****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Food service equipment.
- B. Connections to utilities.

1.02 REFERENCE STANDARDS

- A. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.
- B. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2006.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.
- D. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2008.
- E. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication & Installation Guidelines; 2001
- F. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on appliances; indicate configuration, sizes, materials, finishes, locations, and utility service connection locations, service characteristics, and wiring diagrams.
- C. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- D. Certificates: Certify that products of this section meet or exceed specified requirements.
- E. Operation Data: Provide operating data for the specified equipment.
- F. Maintenance Data: Provide lubrication and periodic maintenance requirement schedules.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of standard products of the type specified.

1.06 REGULATORY REQUIREMENTS

- A. Conform to applicable code for utility requirements.
- B. Products Requiring Electrical Connection: Listed and classified by UL (EAUED) as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products clear of floor in a manner to prevent damage.

- B. Coordinate size of access and route to place of installation.

1.08 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Equipment Schedule: Refer to Food Service drawings Equipment schedule .
 - 1. All Equipment Eligible for Energy Star Rating: Energy Star Rated.
 - 2. Cooler and Freezer Units: Listed by UL standards..
 - 3. Electrical Wiring and Components and Self-Contained Refrigeration Systems: Conform to UL standards.
 - 4. Exhaust Hoods: Comply with NFPA 96 and SMACNA (KVS).
- B. Installation Accessories: Provide all rough-in hardware, supports and connections, attachment devices, closure trim, and accessories required for complete installation.

2.02 FABRICATION

- A. Install rubber button feet on bearing surface of any item positioned on a finished surface.
- B. Isolate rotating or reciprocating machinery to prevent noise and vibration.
- C. Provide indirect drain piping from equipment to terminate over nearest waste receptor.
- D. Accommodate site installation of other services or equipment.

2.03 FINISHES

- A. All Components: Shop finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify ventilation outlets, service connections, and supports are correct and in required location.
- B. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install items in accordance with manufacturers' instructions.
- B. Insulate to prevent electrolysis between dissimilar metals.
- C. Provide sealant to achieve clean joint with adjacent building finishes and between abutting components.

3.03 ADJUSTING

- A. Adjust equipment and apparatus to ensure proper working order and conditions.
- B. Remove and replace equipment creating excessive noise or vibration.

3.04 CLEANING

- A. Remove masking or protective covering from stainless steel and other finished surfaces.
- B. Wash and clean equipment.
- C. Polish glass, plastic, hardware, accessories, fixtures, and fittings.

3.05 CLOSEOUT ACTIVITIES

- A. At completion of work, provide qualified and trained personnel to demonstrate operation of each item of equipment and instruct Owner in operating procedures and maintenance.
 - 1. Test equipment prior to demonstration.
 - 2. Individual Performing Demonstration: Fully knowledgeable of all operating and service aspects of equipment.

3.06 PROTECTION

- A. Remove protective coverings from prefinished work.
- B. Protect finished work from damage.

END OF SECTION

SECTION 11450**RESIDENTIAL EQUIPMENT****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Kitchen appliances.

1.02 RELATED REQUIREMENTS

- A. Section 15145 - Plumbing Piping: Plumbing connections for appliances.
- B. Section 16155 - Equipment Wiring: Electrical connections for appliances.

1.03 REFERENCE STANDARDS

- A. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.
- C. Copies of Warranties: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Electric Appliances: Listed and labeled by UL and complying with NEMA standards.

PART 2 PRODUCTS**2.01 KITCHEN APPLIANCES**

- A. All Equipment Eligible for Energy Star Rating: Energy Star Rated.
- B. Refrigerator: Free-standing, bottom-mounted freezer, frost-free.
 - 1. Capacity: Total minimum storage of 18 cubic ft; minimum 15 percent freezer capacity.
 - 2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by DOE.
 - 3. Features: Include glass shelves.
 - 4. Finish: Stainless steel.
- C. Microwave: Countertop.
 - 1. Capacity: 0.7 cubic ft.
 - 2. Power: 850 watts.
 - 3. Features: Include turntable.
 - 4. Finish: Black.
- D. Dishwasher: Undercounter.
 - 1. Controls: Solid state electronic.
 - 2. Wash Levels: 3.
 - 3. Cycles: 4, including normal and short.
 - 4. Features: Include optional no-heat dry and optional water temperature boost.
 - 5. Finish: Stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify utility rough-ins are present and correctly located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.03 ADJUSTING

- A. Adjust operating equipment to efficient operation.

3.04 CLEANING

- A. Remove packing materials from equipment.
- B. Wash and clean equipment.

END OF SECTION

SECTION 12355**RESIDENTIAL CASEWORK****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Kitchen cabinets. (Breakroom and Nurse Station)
- B. Kitchen countertops.
- C. Casework hardware.

1.02 REFERENCE STANDARDS

- A. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2003 (ANSI/BHMA A156.9).
- B. ANSI/KCMA A161.1 - Performance and Construction Standard for Kitchen and Vanity Cabinets; Kitchen Cabinet Manufacturers Association; 2000 (R2006).
- C. KCMA (DIR) - Directory of Certified Cabinet Manufacturers; Kitchen Cabinet Manufacturers Association; current edition, online.

1.03 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, configurations, and construction details.
- C. Shop Drawings: Indicate casework locations, large scale plans, elevations, clearances required, rough-in and anchor placement dimensions and tolerances, and _____.
- D. Samples: Submit ____ cabinet and countertop samples illustrating color of finish.

1.04 QUALITY ASSURANCE

- A. Products: Complying with KCMA A161.1 and KCMA Certified.
- B. Manufacturer: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 MOCK-UP

- A. Locate where directed.
- B. Mock-up may remain as part of the Work.

PART 2 PRODUCTS**2.01 COMPONENTS**

- A. Cabinet Construction: Softwood lumber framing and particle board, tempered hardboard gables.
- B. Kitchen Countertop: Post formed plastic laminate over particle board, coved to back splash.
- C. Door and Drawer Fronts: Solid wood.
- D. Bolts, Nuts, Washers and Screws: Of size and type to suit application.
- E. Concealed Joint Fasteners: Threaded steel.

2.02 HARDWARE

- A. Hardware: BHMA A156.9, _____.

2.03 FABRICATION

- A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.
- B. Fabricate corners and joints without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.
- C. Fabricate each unit to be rigid and not dependent on building structure for rigidity.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install casework, components and accessories in accordance with manufacturer's instructions.
- B. Set casework items plumb and square, securely anchored to building structure.
- C. Close ends of units, back splashes, shelves and bases.

3.02 ADJUSTING

- A. Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly.

3.03 CLEANING

- A. Clean casework, countertops, shelves, and hardware.

3.04 PROTECTION

- A. Do not permit finished casework to be exposed to continued construction activity.

END OF SECTION

SECTION 14201**PASSENGER ELEVATORS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Complete elevator systems.
- B. Elevator maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 03300 - Cast-in-Place Concrete: _____.
- B. Section 04810 - Unit Masonry Assemblies: Masonry hoistway enclosure; building-in and grouting hoistway door frames.
- C. Section 05500 - Metal Fabrications: Pit ladder, Sill supports, and overhead hoist beams.
- D. Section _____ - _____: Waterproofing of elevator pit walls and floor.
- E. Section 10523 - Fire Extinguishers, Cabinets and Accessories: Fire extinguisher in elevator machine room.

1.03 REFERENCE STANDARDS

- A. ASME A17.1 - Safety Code for Elevators and Escalators; The American Society of Mechanical Engineers; 2007.
- B. ASME A17.2 - Guide for Inspection of Elevators, Escalators, and Moving Walks; The American Society of Mechanical Engineers; 2007.
- C. NFPA 70 - National Electrical Code; National fire Protection Association; 2008.
- D. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association; 2007.
- E. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.
- F. UL (ECMD) - Electrical Construction Materials Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a meeting one week prior to starting work.
 - 1. Review schedule of installation, installation procedures and conditions, and coordination with related work.
 - 2. Review use of elevator for construction purposes, hours of use, scheduling of its use, cleanliness of cab, employment of operator, maintenance of system.
- B. Construction Use of Elevator: Elevator may be used for transport of construction personnel and materials.
 - 1. Enclose cab with protective plywood on floor, walls, and ceiling.
 - 2. Provide temporary lighting.
 - 3. Provide control panel with manual and emergency operation with key operation for attendant operator.

1.05 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate the following information:
 - 1. Locations of machine room equipment: driving machines, controllers, governors and other component.

2. Hoistway components: Car, counterweight, sheaves, machine and sheave beams, guide rails, buffers, ropes, and other components.
- C. Product Data: Provide data on the following items:
 1. Signal and operating fixtures, operating panels, indicators.
 2. Cab design, dimensions, layout, and components.
 3. Cab and hoistway door and frame details.
 4. Electrical characteristics and connection requirements.
- D. Maintenance Contract.
- E. Maintenance Data: Include:
 1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
 2. Technical information for servicing operating equipment.
 3. Legible schematic of wiring diagrams of installed electrical equipment and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with applicable code and ASME A17.1 and as supplemented in this section.

1.07 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.
- B. Provide one year manufacturer warranty for elevator operating equipment and devices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Kone; Product Ecospace.
- B. Other Acceptable Manufacturers:
 1. ThyssenKrupp Elevator: www.thyssenkruppelevator.com.
 2. Otis Elevator Co: www.otis.com.
 3. Schindler Elevator Corp: www.us.schindler.com.
 4. Substitutions: See Section 01600 - Product Requirements.
- C. All components to be manufactured by same entity, unless otherwise indicated.

2.02 ELEVATORS

- A. Elevator: Passenger, gearless electric.
 1. Hoistway Doors and Frames: Stainless steel.
 2. Door Type: Single leaf.
 3. Door Operation: Side opening.
 4. Rated Net Capacity: 2500 lbs.
 5. Rated Speed: 150 ft/min.
 6. Travel Distance: As indicated on drawings.
 7. Number of Stops: 3.
 8. Traction Machine Location: Roof plaza level.

2.03 CONTROLS

- A. Elevator Controls: Provide landing buttons and hall lanterns.
- B. Door Controls:
 1. Program door control to open doors automatically when car arrives at floor.

2. Render "Door Close" button inoperative when car is standing at dispatching terminal with doors open.
 3. If doors are prevented from closing for approximately ten seconds because of an obstruction, automatically disconnect door reopening devices, close doors more slowly until obstruction is cleared. Sound buzzer.
 4. Door Safety Devices: Moveable, retractable safety edges, quiet in operation; equip with photo-electric light rays.
- C. Landing Buttons: Stainless steel type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows.
- D. Interconnect elevator control system with building fire alarm systems.
- E. Provide "Firefighter's Operation" in accordance with applicable code. Designated Landing: _____.

2.04 EMERGENCY POWER

- A. Arrange elevator operation to operate under emergency power when normal power supply fails.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that hoistway, pit, and machine room are ready for work of this section.
- C. Verify hoistway shaft and openings are of correct size and within tolerance.
- D. Verify location and size of machine foundation and position of machine foundation bolts.
- E. Verify that electrical power is available and of the correct characteristics.

3.02 PREPARATION

- A. Arrange for temporary electrical power for installation work and testing of elevator components.

3.03 INSTALLATION

- A. Install system components. Connect equipment to building utilities.
- B. Provide conduit, boxes, wiring, and accessories.
- C. Accommodate equipment in space indicated.
- D. Install guide rails using threaded bolts with metal shims and lock washers under nuts. Compensate for expansion and contraction movement of guide rails.
- E. Accurately machine and align guide rails. Form smooth joints with machined splice plates.
- F. Coordinate installation of hoistway wall construction.
- G. Install hoistway door sills, frames, and headers in hoistway walls. Grout sills in place. Set entrances in vertical alignment with car openings and aligned with plumb hoistway lines.
- H. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime two coats.
- I. Machine Room Components: Clean and degrease; prime one coat, finish with one coat of enamel.
- J. Adjust equipment for smooth and quiet operation.

3.04 ERECTION TOLERANCES

- A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1.

- B. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.05 FIELD QUALITY CONTROL

- A. Testing and inspection by regulatory agencies will be performed at their discretion.
 - 1. Schedule tests with agencies and notify Owner and Architect.
 - 2. Obtain permits required to perform tests.
 - 3. Document regulatory agency tests and inspections in accordance with the requirements of Section 01400.
 - 4. Perform tests required by regulatory agencies.
 - 5. Furnish test and approval certificates issued by authorities having jurisdiction.
- B. Perform testing and inspection in accordance with requirements of Section 01400.
 - 1. Perform tests as required by ASME A17.2.
 - 2. Provide two weeks written notice of date and time of tests.
 - 3. Supply instruments and execute specific tests.

3.06 ADJUSTING

- A. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.
- B. Adjust automatic floor leveling feature at each floor to achieve 1/4 inch from flush.

3.07 CLEANING

- A. Remove protective coverings from finished surfaces.
- B. Clean surfaces and components ready for inspection.

3.08 PROTECTION

- A. Do not permit construction traffic within cab after cleaning.
- B. Protect installed products until project completion.
- C. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

3.09 MAINTENANCE

- A. See Section 01700 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer or original installer.
- C. Provide service and maintenance of elevator system and components for one year from Date of Substantial Completion.
- D. Examine system components monthly. Clean, adjust, and lubricate equipment.
- E. Include systematic examination, adjustment, and lubrication of elevator equipment. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.
- F. Perform work without removing cars during peak traffic periods.
- G. Maintain an adequate stock of parts for replacement or emergency purposes locally, near the place of the Work. Have personnel available to ensure the fulfillment of this maintenance service, without unreasonable loss of time.

END OF SECTION

SECTION 14250**DUMBWAITERS****PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Furnish and provide all materials and labor necessary for the complete installation of one Ambassador DR dumbwaiter.
- B. Obtain information on conditions affecting work at jobsite. Including verification of dimensions, field material for anchoring, accessibility and storage space. Verify voltages and outlets on electrical drawings.

1.02 WORK DONE BY OTHERS

- A. Suitable, legal, two-hour fire rated hoistway, if consistent with building construction.
- B. Hoistway door walls must not be erected until doors are set in place.
- C. Electrician shall furnish power supply with line disconnect switch immediately adjoining the controller cabinet.
- D. Hoistway free of all pipes and obstructions.
- E. All bracket fastening inserts and other steel required for support of guide rails and brackets.
- F. Painting of exterior walls and prime finished components that are exposed to view, including inside of car, car gates and doors.
- G. Machine area lighting and convenience outlet.

1.03 REFERENCES

- A. Design and installation shall be in compliance with regulations and all governing agencies. Lift shall be subject to local, city and state approval prior to installation, along with city and state inspection after installation. Special local requirements shall be determined and handled locally by distributor with manufacturer's agreement.

1.04 SUBMITTALS

- A. Submit drawings or manufacturer's literature for approval. Drawings shall show rough-in requirements and wiring materials.

1.05 SUBSTITUTIONS

- A. No substitutions will be considered unless a written request for approval has been submitted by the bidder and was received by the architect at least ten (10) days prior to the date of receipt of bids. Each such request shall include the name of the materials for which it is to be substituted. Also provide a complete description of the proposed substitute including the drawings, cuts, performance and test data, a list of projects of similar scope, photographs of existing installations and any other information necessary for evaluation.

1.06 TESTING

- A. The dumbwaiter shall be tested after installation to demonstrate:
 - 1. Accuracy of stops
 - 2. Operation of hoistway door locks and car gate switch(es).
 - 3. Operation of final terminal switches
 - 4. Operation of push-button and key switches
 - 5. Capacity load test. Operate dumbwaiter for a period of twenty (20) minutes with a capacity load. Run dumbwaiter from top terminal floor to bottom floor with one minute between starts after each stop.

PART 2 - PRODUCTS**2.01 MANUFACTURER**

- A. Matot Inc., Bellwood, Illinois, www.matot.com

2.02 PRODUCT TYPE

- A. Model shall be the Ambassador DR drum Dumbwaiter
- B. Car shall have clear inside dimensions of 42 inches wide x 35 inches deep x 48 inches high. Capacity to be 500 pounds. Dumbwaiter to serve 2 stops and 2 openings, located on opposite sides of the hoistway. The car shall stop at floor level. The travel distance shall be 12 feet- 8 inches. Power supply shall be 480 volt, 3 phase, 60 hertz.
- C. All equipment shall be manufactured in accordance with the latest edition of the ANSI 17.1 code for elevators, escalators and dumbwaiters.

2.03 FABRICATION

- A. Car Enclosure: The car shall be constructed of 16 gauge # 4 satin polished stainless steel finish. An electrical light fixture shall be recessed in the ceiling. Floor loading models shall have a reinforced floor.
- B. Car Gates: The car shall be equipped on each open side with a gate matching the car construction and finish. The gate shall be vertical bi-parting design. Car gate(s) shall be manually operated.
- C. Guide Rails: Steel "Tee" rails shall be furnished to guide the car. Guide rails shall be mounted to the floor slabs and hoistway wall with steel brackets.
- D. Machine: Machine shall be the winding drum type. Single speed motor shall be of ample horsepower to lift the rated load at the rated speed, with a high starting torque and low starting current. It shall be equipped with a spring applied and electrically released brake. Machine shall be located at the top of the hoistway and mounted on structural steel base.
- E. Controller: Controller shall be a wall-mounted type with lockable door, located on hoistway outer wall in sight of machine access door. The controller shall be a solid state programmable and Underwriter's Laboratories, Inc. listed.
- F. Operational Control: Operation shall be automatic call and send. A pushbutton station with one button for each level served shall be furnished at each door. It shall be possible at each level to call the car or send it to any other level. Pushbuttons shall be inoperative while car is in transit and for a few seconds after arrival at the selected level. Pushbuttons shall have stainless steel faceplates.
- G. Signals Devices:
1. "Door Open" call buzzer - shall sound when a pushbutton is pressed and a hoistway door or car gate is open.
 2. "Car Here" light and chime - shall be located in each pushbutton station. Chime shall indicate car arrival. Light shall indicate car presence.
 3. Combination "Door Open" and "In-Use" light - shall be located in each pushbutton station. Light will illuminate when car is in transit and when a pushbutton is pressed and a hoistway door or gate is open.
- H. Leveling Accuracy: The car floor shall be no more than 1/4" above or below the level of the hoistway door -sill.
- I. Hoist Ropes. One 3/16" x 7 x 19 galvanized aircraft cable with safety factor per code.
- J. Final Limit Stopping Devices: Provide per code
- K. Guide Shoes: Guide shoes shall be adjustable, renewable dry type.
- L. Hoistway Doors: Door shall be vertical sliding bi-parting design. Each door shall bear the Underwriters "B" label and shall be rated for application in; (a) masonry shaft or (b) metal stud drywall shaft. Hollow

metal door panels shall be 16 gauge stainless steel with satin polish & No.4 finish. Welded unit wall frame, including jambs, trim and sill shall be; 16 gauge stainless steel with satin polish & No.4 finish. Doors shall be manually operated. A door lock and contact shall be provided on each door.

- M. Machine Access Door: Hinged access door shall be 24" w x 24"h and shall be furnished at machine location for service and maintenance. Access door shall be 16 gauge stainless steel with satin polish & No.4 finish

2.04 PERFORMANCE

- A. Rated load 500 pound capacity
- B. Nominal travel speed shall be 50 F.P.M.
- C. Leveling Accuracy: Car floor shall be no more than 1/4" above or below the level of the hoistway door-sill.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Coordinate work with general contractor.
- B. Leave standard electrical connection drawings with electrical contractor to make final electrical connection. Wiring within unit shall be done as part of work of this section, 20-amp circuit required.
- C. The installation of the dumbwaiter shall be made in accordance with the approved plans and specifications and manufacture's installation instructions.

END OF SECTION

**SECTION 15010
GENERAL 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.
- B. Refer to Division 1 Specifications for general requirements of the following items:
1. Work by Owner.
 2. Work sequencing and phasing.

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
ABMA:	American Boiler Manufacturer's Association
ADA:	Americans with Disabilities Act
ADC:	Air Diffuser Council
AGA:	American Gas Association
AMCA:	Air Moving and Conditioning Association
ANSI:	American National Standards Institute
API:	American Petroleum 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
ASPE:	American Society of Plumbing Engineers
ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
AWWA:	American Water Works Association
CGA:	Compressed Gas Association
CTI:	Cooling Tower Institute
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
PDI:	Plumbing and Drainage Institute
PFI:	Pipe Fabrication Institute

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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 DRAWINGS AND CONFLICTS:

- 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. 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 or not specifically mentioned.
- D. Should a discrepancy exist between the mechanical drawings and the mechanical specifications it is the contractor's responsibility to include that portion or portions of the more expensive item in his/her bid. Final approval and/or directive can then be forwarded to the contractor during the submittal process.

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, horse powers 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,

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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 on all mechanical equipment and shop drawings for sheetmetal ductwork. 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. Contractor is responsible for the timely preparation and submission of ¼" = 1'- 0" sheetmetal shop drawings indicating all items necessary for complete coordination and fabrication/installation. Contractor is also responsible for the timely preparation and submission of ½ " = 1' – 0" shop drawings indicating all HVAC equipment piping, and required sheetmetal ductwork in mechanical room areas and or critical areas that mandate a thorough review of the systems. Engineer will review these drawings for compliance and offer comments and or suggestions Unless the engineer deems a change in work scope is worthy of being classified a substantial change, no additional compensation will be approved for additional shop drawings. Receipt of approved shop drawings , however , does not preclude the contractor's responsibility to provide the owner a project complete in every aspect in accordance with the contract documents .
 2. Each submittal will be reviewed for compliance with general requirements of design and arrangement only; 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

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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.
7. The suggested production of Drawings is as follows, however, the Contractor is solely responsible for the means, methods and sequences used:
 - (a) Mechanical trade shall initiate these drawings including furnishing of floor plan backgrounds. Sequence of preparation shall be:
 - i) Ductwork
 - ii) Remainder of mechanical work including equipment and piping.
 - (b) Plumbing trade shall show piping (supply, waste, vent, etc.) overlaid on the floor plan furnished by mechanical trade.
 - (c) Fire protection work shall be shown on the same floor plan after completion of plumbing work drawings.
 - (d) Electrical trade work shall be shown on the same floor plan after completion of the above.
 - (e) General trade work shall be shown on the same floor plan after completion of the above.
- 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 four (4) 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.

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2. Operation and Maintenance instructions shall be submitted and approved prior to instruction of Owner's personnel in the various systems operation and maintenance.
3. The control sequence indicates how the systems integrate and operate in conjunction with each other. It is the owner's responsibility to maintain and operate each piece of equipment in accordance with the manufacturer's requirements. It is recommended that the HVAC system inclusive of the outside air units (if so indicated) be enabled to operate during unoccupied periods. Should the building be unoccupied for periods longer than 36 hours, the complete HVAC system should be enabled in order to maintain acceptable temperature and humidity limits. Failure to do so, could result in unacceptable indoor environmental conditions.

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 by the Architect and Owner. 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. Any cost of repairs to the system required as a result of operating the MEP systems prior to the final acceptance by owner and architect shall be borne solely by the contractor.
- 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.

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- C. Equipment warranties extending beyond the first year warranty generally include material only guarantees. Owner is responsible for additional expenses and the assembly of adequate record keeping during his/her warranty period.

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 Engineer, 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.
- C. Manufacturers and power requirements indicated on the mechanical and electrical drawings are the basis of design. If changes are required for the equipment submitted, such as changes in conduit size, conductors, breakers, disconnects, panels, etc., it shall be made at no additional cost to the Owner.

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 1/2 horsepower or less shall be single phase, the motors rated at 3/4 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.

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- 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 AND ELECTRICAL INTERLOCKS:

- A. Except where otherwise specified or as included as an integral part of the normal and customary mechanical equipment, each starter shall be furnished by other divisions complete with the required control power transformers and auxiliary contacts necessary for control interlocks and wired by a licensed electrician in accordance to governing codes.
- B. In Fractional horsepower 120v-single phase roof or wall mounted fans, a motor rated manual starter/disconnect with on-off snap switch type with soldered ratchet overload protection shall be furnished by the contractor furnishing the fans and wired by a licensed electrician in accordance to governing codes.
- C. When interlocking of equipment is required all wiring in excess of 50 volts to be provided by a licensed master electrician and coordinated by the contractor. All other wiring 50 volts or less or as required by the controls/energy management system shall be fully coordinated by the contractor to provide and assure a complete and fully operational system. All conduit for controls and or power wiring shall be in accordance with division 16 requirements, and installed by licensed electrician and coordinated by the contractor.
- D. Except for such items that are normally wired up to their point of manufacture and so delivered and unless specifically noted to the contrary herein, the Contractor shall do all electric wiring of every character for interlocking, pilot, and control in accordance with methods and materials described within Division 16 of these Specifications. This includes conduits and mounting of all electrical devices.
- E. Furnishing of complete wiring diagrams showing proper control and interlock wiring shall be work under the trade supplying the equipment. Diagrams shall be based on the approved equipment for this project and shall be complete integral drawings, not a series of manufacturers individual diagrams.
- F. The electrical design and drawings are based on the equipment scheduled and shown on the mechanical drawings and should any mechanical equipment requiring changes to the electrical design be approved, the required electrical changes shall be made at no cost to the Owner.

2.5 CONTROL POWER AND EQUIPMENT POWER FOR CONTROLS:

- A. Control power, whether it be DDC, 24 volt, or 120 volt, should be delivered to each piece of mechanical equipment, fire/smoke dampers, and/ or control panels **whether or not** it is specifically indicated on the contract drawings.
- B. It is the contractor's responsibility to include in his or her bid all costs in connection with

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control wiring, and/or power, **whether or not** it is specifically indicated. Regardless of how large in nature or how incidental, no additional compensation will be approved by the owner/arch/engineer concerning a failure on the contractors part to include these costs in his or her bid or a failure on the contractors part to properly coordinate these important functions.

2.6 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.

2.7 LIFE SAFETIES FIRE SMOKE DAMPERS:

- A. It is the contractor's responsibility to coordinate with the architectural drawings and verify the need for fire and or fire smoke dampers whether or not they are specifically indicated. Additionally it is the contractor's responsibility to include in his/her bid the cost to furnish and install fire and or fire/smoke dampers required by code, whether or not they are specifically indicated.
- B. It is the contractor's responsibility to coordinate with other applicable trades to determine the proper voltage of the fire/smoke damper operator and the proper sequencing of the damper operation. Refer to 15010-2.4 and other section of Division 15 and Division 16 for the requirements for the damper operator wiring.

2.8 PENETRATIONS THROUGH FIRE-RATED ASSEMBLIES:

- A. Seal voids around ducts and pipes penetrating fire-rated assemblies and partitions using fire-stopping materials and methods in accordance with provisions in Series 0700 Fire-Stopping.

2.9 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. Nameplates 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

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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. All work shall be installed in such a manner to receive authority having jurisdiction's approval whether it concerns operation, maintenance or life safety. Should the contractor install items that do not comply with

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code authorities, it shall be the contractors' responsibility to correct the deficiency at his or her own expense without burden to the project schedule. Additionally, reasonable attempts have been made in these documents to convey the design knowledge available to our office and to indicate placement of HVAC equipment in a diagrammatical nature. Each and every fitting, offset, other appurtenance, exact unit placement, etc has not been indicated. Therefore, in accordance to local code and the requests of the owner, final exact unit or device placement is the complete responsibility of the contractor. Receipt of approved shop drawings or the "scaling" of our documents do not relieve the contractor of his/her contractual responsibility to provide (but not limited to) ---1) owner requested clearances2) clearances required by the manufacturer 3) clearances required by code, 4) a project complete in every aspect. Should the contractor place material, a device or an HVAC unit in such a manner as to circumvent the requirements noted above, the unit, device or associated material shall be relocated at the contractors' sole expense with no cost whatsoever to the owner or engineer.

- 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.
- E. The installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the Contractor in the determination of which trade shall be given the "Right-of-Way".

- Building lines
- Structural Members
- Soil and Drain Piping
- Condensate Drains
- Vent Piping
- Supply, Return, and Outside Air Ductwork
- Exhaust Ductwork
- HVAC Water and Steam Piping
- Steam Condensate Piping
- Fire Protection Piping
- Natural Gas Piping
- Domestic Water (Cold and Hot)
- Refrigerant Piping
- Electrical Conduit

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

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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. Leak test of all renovated and new draining systems.
 - 2. Pressure test of all renovated and new pressure piping systems.
 - 3. Renovated and new domestic water piping system sterilization.
 - 4. Equipment performance tests.

3.9 FILTERS AND AIR HANDLING UNIT SHEAVES:

- A. Provide one set of final filters at time of project acceptance by the owner and /or Architect. Provide a minimum of one set of construction filter during project start up & run test. Should the HVAC equipment be utilized for a period of time prior to final Owner/Architect acceptance, it shall be the contractors responsibility to maintain said

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HVAC equipment, replace filters as required and or clean the equipment inclusive of the coils prior to final owner/Architect's acceptance.

- B. The contractor is expected to work closely with the testing and balancing firm to provide the owner with a complete and functional system. Should the testing and balancing firm request AHU sheave change the contractor should include in his/her price all costs in connection with the replacement of drive and driven sheaves inclusive of belt change if required. These costs could include temporary lifts, overtime labor , or other items in order to complete the task suggested by the TAB firm .

3.10 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.

3.11 DEHUMIDIFICATION OF BUILDING:

- A. It shall be the contractor's responsibility to properly dry the building and dehumidify the space prior to activating the HVAC system. Extra precautions should be taken by the contractor not to allow excessive humidity to develop in the building prior to final connection and activation of the HVAC system. Should it become necessary, the contractor shall procure the required equipment to properly dry and dehumidify the space so as not to force the HVAC to perform beyond its intended ability.
- B. The contractor is responsible for all costs in connection with repair and/or activation to the building and its HVAC system should excess moisture cause damage.

END OF SECTION

**SECTION 15014
CONDENSATE DRAINAGE SYSTEM**

PART 1. GENERAL**1.1 GENERAL:**

- A. Refer to Section 15010 for General Requirements for Mechanical Work.

1.2 SCOPE:

- A. Provide all labor, materials, equipment, tools and services and perform all operations required in connection with incidental to the construction of complete condensate drainage systems indicated on the drawings, reasonably implied therefrom or as specified herein unless specifically excluded.

1.3 INSTALLATION OF PIPING:

- A. All piping shall be run in the most direct manner. Horizontal piping shall have a grade of one-eighth (1/8") per foot. All offsets shall be 45 degrees or less.
- B. Flash all pipe openings through the roof, using 4# sheet lead or other approved material. Construct the flashing with a base 10 inches beyond the pipe openings in all four directions and extend the vertical tube up the pipe and terminate by turning into the pipe cavity at least 2 inches in size and larger and terminating in a specially fabricated flashing fitting on pipe sizes 1-1/2 inch and smaller. The Plumbing Contractor shall fabricate flashing and turn over to the roofer to install at the roof level and after completion of this installation he shall finish the top of the flashing as hereinbefore specified.

1.4 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. Extend condensate drain piping from each air handling unit to the nearest approved sanitary drain.

END OF SECTION

**SECTION 15020
MECHANICAL AND ELECTRICAL COORDINATION**

PART 1. GENERAL

1.1 RELATED DOCUMENTS:

- A. Refer to Section 15010 – General Requirements for Mechanical Work.

1.2 SUMMARY:

- A. This Section describes a suggested **guide** coordination only between the Mechanical and Electrical portions of the work.
- B. This Section is included under the Division 16 portion of the Specifications.

1.3 INTENT:

- A. This section is an effort to indicate the pertinent mechanical and electrical items that generally requires close coordination. The schedule listed below is a suggestion only indicating that which is normal and customary practices in the industry; but shall not preclude the contractor from coordinating and directing the MEP systems as he/she so chooses.

1.4 RESPONSIBILITY:

- A. It is the contractor’s responsibility to determine scope and direction of each of his/her subcontractors and coordinate the MEP systems providing the owner with a complete and fully operating MEP system as contained by Division 15 and Division16.

1.5 WORK INCLUDED:

- A. Responsibility: Unless otherwise directed by the contractor, motors and controls shall be furnished, set in place and wired in accordance with the following schedule. This schedule may include equipment and systems that are not required for this project. **Only the equipment and systems that are required on the drawings and/or specified elsewhere will be required by this section:**

<u>ITEM</u>	<u>FURNISHED UNDER DIVISION</u>	<u>INSTALLED IN ACCORD TO DIVISION</u>	<u>WIRED CONNECTED IN ACCORD TO DIVISION</u>
1. Equipment Motors	15	15	16
2. Magnetic Motor Starters			
a. Automatically controlled, with or without HOA switches.	16	16	Notes 1,3,5
b. Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment.	16	15	Notes 1,3,5
c. Manually controlled	16	16	Notes, 1,3,5
d. Manually controlled and Notes 1,3, 5 furnished as part of factory wired equipment.	15	15	
e. Furnished in Motor Control	16	16	

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	Notes 1,3,5 Centers			
3.	Adjustable frequency AC Drives	15	16	
4.	Line voltage thermostats, time clocks, etc. not connected to control panel systems.	15	16	16
5.	Electric thermostats, time clocks, remote bulb thermostats, motorized valves float controls, etc., which are an integral part or directly attached to ducts, pipes, etc.	15	15	15
6.	Temperature control panels and time switches mounted on temperature control panels.	15	15	15
7.	Motorized valves, motorized dampers solenoid valves, EP and PE switches, etc.	15	15	15
8.	Alarm bells furnished with equipment installed by Division 15.	15	15	16
9.	Wiring to obtain power for control circuits including circuit breaker.	15	16	16
10.	Low voltage controls, thermostats, valves, dampers, etc.	15	15	15
11.	Fire protection system (sprinkler) controls.	15	15	16
12.	Fire and smoke detectors installed on mechanical units and in ductwork.	16	16	16/Note 2
13.	All relays required for fan shutdown, motorized dampers, smoke control devices, and other items integral with HVAC equipment provide operation and control of HVAC equipment.	15	15	15
14.	Boiler and water heater controls, boiler burner control panels.	15	15	15
15.	Pushbutton stations, pilot lights	15	15	15
16.	Heat Tape	15	15	16
17.	Disconnect switches, manual operating switches furnished as a part of the equipment.	15	15	Notes 1,5
18.	Disconnect switches, manual operating switches furnished separate from equipment.	16	16	16

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19.	Multi-speed switches	15	15	16
20.	Thermal overloads.	15	16	16
21.	Control relays, transformers	15	15	15
22.	Refrigeration cycle, cooling tower and control.	15	15	15
23.	Tamper switches for fire protection (sprinkler systems)	15	15	16
24.	Flow switches for fire protection (sprinkler) system	15	15	16
25.	Fire and jockey pump controllers and Note 6 automatic transfer switch.	15	15	Note 6
26.	Alarm bells or horns for fire protection (sprinkler) system	15	15	16
27.	Generator (underground) fuel tank	15	15	--
28.	Generator fuel level indicator	16	16	16
29.	Generator fuel piping from tank to generator	15	15	--
30.	Underground fuel tank leak detection and monitoring system	15	15	15
31.	Fireman's control panel for Mechanical equipment only	15	16	16
32.	Chemical treatment devices	15	16	16
33.	Fire alarm system	16	16	16

- NOTES:**
- (1) Power wiring as defined in Section 16160 of the specifications shall be as directed by division 16; control wiring as defined in Section 16160 of the specifications shall be as directed by Division 15 and governed by division 16 and the NEC.
 - (2) Wiring from alarm contacts to alarm system by Division 16; wiring from auxiliary contacts to air handling system controls by division 15. Smoke detectors required for all air-handling systems 2000 CFM or greater. Refer to Division 16 specifications and drawings for more specific requirements.
 - (3) For requirements for Magnetic Motor Starters, refer to Division 15 Section 15010.
 - (4) For requirements for Adjustable Frequency AC drives, refer to Division 15 Section 15950.
 - (5) Disconnect switches, operating switches, starters and other similar items, which are factory-mounted as a part of a complete assembly, shall comply with applicable provisions of the National electric Code. All such disconnect switches shall be fused.
 - (6) Power wiring from energy source to controllers and automatic transfer switch shall be under Division 16. Interconnecting power and control wiring from controllers and automatic transfer switch to pumps shall be under Division 15 and conforming to Division 16. Control wiring from automatic transfer switch to generator starter shall be under Division 16.

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GENERAL NOTES: (1) Refer to Division 15 control system for additional specific requirements.

(2) In accordance to national electrical code all wiring in excess of 50 volts shall be furnished by a licensed electrician.

A. Connections: Make all connections to controls, which are directly attached to ducts. Piping and mechanical equipment with flexible connections.

B. Precedence:

1. In general, piping systems, which require a stated grade for proper operation shall have precedence over other systems in which direct conflict occurs.

2. As a general rule precedence for pipe, conduit and duct systems shall be as follows:

Building lines
Structural Members
Soil and Drain Piping
Condensate Drains
Vent Piping
Supply, Return, and Outside Air Ductwork
Exhaust Ductwork
HVAC Water and Steam Piping
Steam Condensate Piping
Fire Protection Piping
Natural Gas Piping
Domestic Water (Cold and Hot)
Refrigerant Piping
Electrical Conduit

Note: However it's the contractor's responsibility to coordinate these items so as to prevent additional cost to the owner providing the owner a fully operating MEP complete in every way.

3. Lighting Fixtures shall have precedence over air grilles and diffusers, where direct conflict occurs.

C. Final Inspection And Report:

At the completion of the work, there shall be a meeting of the Mechanical Electrical and Temperature control Contractors, representatives of mechanical and electrical equipment manufacturers whose equipment was actually installed on the project, and similarly-involved individuals, who shall thoroughly inspect all systems, and who shall mutually agree that all equipment has been properly wired and installed, and that all temperature and safety controls are properly functioning. A written report of this meeting, listing those in attendance, and the companies, which they represent, shall be filed with the Owner and Architect/Engineer.

END OF SECTION

SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Escutcheons.
5. Sleeves and sleeve seals.

B. Related Section:

1. Division 2 Section "Water Distribution" for water-service piping outside the building from source to the point where water-service piping enters the building.
2. Division 15 Section "Domestic water specialties"

1.3 PERFORMANCE REQUIREMENTS

- A. Provide water a maximum water pressure of 70 psig, for water distribution.

1.4 SUBMITTALS

A. Product Data: For the following products:

1. Pipe and pipe fittings
2. Specialty valves.
3. Transition fittings.
4. Dielectric fittings.
5. Escutcheons.
6. Sleeves and sleeve seals.

- B. Water Samples: Specified in "Cleaning" Article.

- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Sanitary sewer piping.
 - 4. Natural Gas piping
 - 5. Acid waste piping
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.4 ENCASUREMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Sheet or Tube.
- C. Material: LLDPE film of 0.008-inch minimum thickness.

- D. Color: Black.

2.5 SPECIALTY VALVES

- A. Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Hart Industries International, Inc.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.8 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
- D. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- E. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.9 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

2.10 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction

loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- F. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- J. Install piping adjacent to equipment and specialties to allow service and maintenance.
- K. Install piping to permit valve servicing.
- L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- P. Install thermostats in hot-water circulation piping.
- Q. Install thermometers on inlet and outlet piping from each water heater.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE SCHEDULE

- A. Basis-of-Design Product: Subject to compliance provide Watts, or a comparable product by the following:
 - a. Hammond Valve
 - b. NIBCO Inc.
- 2. Pipe NPS 2 and Smaller:
 - a. Brass Valves: May be provided with solder-joints ends instead of threaded ends.
 - b. Bronze Angle Valves: Class 125, bronze disc
 - c. Ball Valves: Two piece, full port brass or bronze with bronze trim.
 - d. Bronze Swing Check Valves: Class 125 bronze disc.
- B. Basis-of-Design Product: Subject to compliance provide Watts, or a comparable product by the following:
 - a. Hammond Valves
 - b. NIBCO Inc.
- 2. Pipe NPS 2-1/2 and Larger:
 - a. Iron Ball Valves: Class 150
 - b. Iron, Single-Flange Butterfly Valves: 200 CWP, EODM seat stainless steel disc.
 - c. Iron Swing Check Valves: Class 125 metal seats.

3.5 VALVE INSTALLATION

- A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures

that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

- B. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller.

3.6 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.

3.7 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.

3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

- E. Install supports for vertical copper tubing every 10 feet.
- F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.10 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 5. Bare Piping in Equipment Rooms: One piece, cast brass.
 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.11 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- D. Install sleeves in new partitions, slabs, and walls as they are built.
- E. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants" for joint sealants.
- F. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants" for joint sealants.
- G. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.
- H. Seal space outside of sleeves in concrete slabs and walls with grout.
- I. Install sleeve materials according to the following applications:
 - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
 - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 - 4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
 - 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - c. Do not use sleeves when wall penetration systems are used.
 - 6. Sleeves for Piping Passing through Interior Concrete Walls:

- a. Steel pipe sleeves for pipes smaller than NPS 6.
- J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.

3.12 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.14 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

- d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.16 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:
 1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- D. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and brazed joints.
- E. Aboveground domestic water piping, NPS 4 and smaller, shall be the following:
 1. Hard copper tube, ASTM B 88, Type L; cast- copper solder-joint fittings; and brazed joints.

3.17 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 15140

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Backflow preventers.
 - 2. Balancing valves.
 - 3. Temperature-actuated water mixing valves.
 - 4. Wall hydrants.
 - 5. Water hammer arresters.
 - 6. Trap-seal primer valves.
- B. Related Sections include the following:
 - 1. Division 15 Section "Emergency Plumbing Fixtures" for water tempering equipment.
 - 2. Division 15 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Contractor shall provide Owner and Engineer "Record drawings" in cad format with 2008 version or higher
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. 009-QT or a comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Size: As indicated on plans
6. Body: Bronze for NPS 2 and smaller.
7. End Connections: Threaded for NPS 2 and smaller.
8. Configuration: Designed for horizontal, straight through flow and top access.
9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check Backflow-Prevention Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. 007-QT or a comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Size: As indicated on plans
5. Body: Bronze for NPS 2 and smaller.
6. End Connections: Threaded for NPS 2 and smaller.
7. Configuration: Designed for horizontal, straight through flow and top access..
8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller.

2.2 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Plumbing Contractor shall verify site water pressure, and provide a water pressure regulator if not on Civil drawings or specification, set water pressure at not to exceed 70 psig.
2. Basis-of-Design Product: Subject to compliance with requirements, provide Watts No. N223B series or a comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Zurn Plumbing Products Group; Wilkins Div.
3. Standard: ASSE 1003.
4. Pressure Rating: Initial working pressure of 150 psig.
5. Size: 4 NPS.
6. Design Flow Rate: 105 gpm
7. Design Outlet Pressure Setting: 70 psig.
8. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.3 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts No. CSM-61 series or a comparable products by one of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Div.
 - b. Hammond Valve.
2. Standard: Bronze housing.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves MV-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Lawler No. 61-25 Unit No. 84008 or a comparable product by one of the following:

- a. Powers; a Watts Industries Co.
 - b. Bradley
2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig.
 4. Type: Cabinet-mounting, thermostatically controlled water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
 9. Tempered-Water Setting: 120 deg. F
 10. Valve Finish: Polished, chrome plated.
 11. Piping Finish: Chrome plated.
- B. Emergency Fixture, Thermostatic, Water Mixing Valves MV-2:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Lawler No. 911 as indicated on Drawings or a comparable product by one of the following:
 - a. Powers; a Watts Industries Co.
 - b. Bradley
 2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig.
 4. Type: Cabinet-mounting, thermostatically controlled water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
 9. Tempered-Water Setting: 85 deg. F
 10. Valve Finish: Polished, chrome plated.
 11. Piping Finish: Chrome plated.
- C. Primary, Thermostatic, Water Mixing Valves MV-3:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Lawler No. 61-25 Unit No. 84008 or a comparable product by one of the following:
 - a. Powers; a Watts Industries Co.
 - b. Bradley
 2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig.
 4. Type: Cabinet-mounting, thermostatically controlled water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.

9. Tempered-Water Setting: 140 deg. F
10. Valve Finish: Polished, chrome plated.
11. Piping Finish: Chrome plated.
- 12.

D. Primary, Thermostatic, Water Mixing Valves MV-4 thru 9:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Lawler No. 61-25, Unit No. 84008 or a comparable product by one of the following:
 - a. Powers; a Watts Industries Co.
 - b. Bradley
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Exposed-mounting, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Tempered-Water Setting: 130 deg F.
10. Selected Valve Flow Rate at 5-psig Pressure Drop: 6.0 gpm.
11. Valve Finish: Chrome plated.
12. Piping Finish: Chrome plated.
13. Inlet & Outlet Size: NPS ¾
14. Accessories: Unit shall be supplied with factory installed Thermometer (0-200 deg. F) and shut off valve on outlet side.

2.5 HOSE BIBBS

2.6 WALL HYDRANTS

A. Non-freeze Wall Hydrants WHY-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z1300-SS, encased non-freeze anti-siphon automatic draining products by one of the following:
 - a. MIFAB, Inc.
 - b. Watts Drainage Products Inc.
 - c. Woodford Manufacturing Company.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.

7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Stainless Steel
10. Operating Keys(s): Two with each wall hydrant.

2.7 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mifab No. M-500 by one of the following:
 - a. PPP Inc.
 - b. Watts Drainage Products Inc.: Series 15
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.8 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mifab No. M-500 by one of the following
 - a. PPP Inc.
 - b. Sioux Chief Manufacturing Company, Inc.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide Smith, Jay R. Mfg. Co.; "Prime-EZE". No field fabrications.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.
5. Locations: Single and main restroom only.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 6 Section "Rough Carpentry."
- G. Install water hammer arresters in water piping according to PDI-WH 201.
- H. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Reduced-pressure-principle backflow preventers.
 - 2. Double-check backflow-prevention assemblies.
 - 3. Water pressure-reducing valves.
 - 4. Calibrated balancing valves.
 - 5. Primary, thermostatic, water mixing valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer and double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
 - 2. Tester Qualifications: All backflow testing shall be performed by a current State of Texas Licensed Backflow Assembly Tester (BAT), tester shall be currently registered by the City of Houston.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 15145

SECTION 15150 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Related Sections include the following:
 - 1. Division 15 Section "Chemical-Waste Piping" for chemical-waste and vent piping systems.
 - 2. Division 15 Section "Sanitary Waste piping Specialties" for floor drains and accessories.

1.3 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction
- B. Building Drain (Sanitary): That part of the lowest piping of a drainage system that receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer beginning two (2) feet outside the building.
- C. Building Sewer: That part of the horizontal piping of a drainage system that extends from the end of the building drain and that receives the discharge of the building drain and conveys it to a public sewer, private sewage disposal or other point of disposal.
- D. CISPI: Cast Iron Soil Pipe Institute
- E. NSF: National Sanitation Foundation.
- F. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:
 1. Contractor shall provide Owner and Engineer "Record drawings" in cad format with 2008 version or higher.
- C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection: Domestic manufactures only.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Charlotte Pipe & Foundry products or by one of the manufacturers specified.
 - a. Tyler Pipe
 - b. ABS, Inc.
 2. Domestic Manufactures Only, All cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class (es).

- B. Compression Gaskets: Charlotte No. SV900, ASTM C 564, rubber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS – Base Bid

- A. Pipe and Fittings: CISPI 301.
- B. Shielded Couplings: Charlotte ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - a. Acceptable Manufacturers:
 - 1) Mission Rubber Co.
 - 2) Tyler Pipe; Soil Pipe Div.
 - 2. Number of Clamps Chart:
 - a. NPS 1-1/2 through NPS 4: 2
 - b. NPS 5 through NPS 10: 4

2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch minimum thickness.
- B. Form: Sheet.
- C. Color: Black.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Aboveground, soil and waste piping shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
- B. Aboveground, vent piping shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

- C. Underground, soil and waste piping shall be the following:
 - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

3.3 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 2 Section "Sanitary Sewerage."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Basis-of-Design: Subject to compliance provide B-Line, or a comparable product by the following:
 - 1. ERICO/Michigan Hanger Co
 - 2. Portable Pipe Hanger
- B. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15150END OF SECTION 15150

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Miscellaneous sanitary drainage piping specialties.
 - 6. Grease Interceptor.

1.3 DEFINITIONS

- A. PE: Polyethylene plastic.
- B. PP: Polypropylene plastic.
- C. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Grease interceptors.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

- B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z1400 or a comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Watts Drainage Products Inc.
2. Standard: ASME A112.36.2M for cast iron.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe as required to match connected piping.
5. Closure: Countersunk or raised-head, plastic plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Gas and watertight, ABS tapered threaded plug

- B. Metal Floor Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. ZN1400 or a comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Watts Drainage Products Inc.
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Spigot to match connected branch..
8. Closure: Gas and water tight ABS tapered thread plug.
9. Adjustable Housing Material: Cast iron with.
10. Frame and Cover Material and Finish: Polished Nickel Bronze.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.

15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z1446 or a comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Watts Drainage Products Inc.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: , drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains: FD-1

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. ZN415 or a comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Watts Drainage Products Inc.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Nickel bronze.
12. Top of Body and Strainer Finish: Nickel bronze.
13. Top Shape: Round.
14. Dimensions of Top or Strainer: Dura-coated cast iron body with combination invertible membrane clamp and adjustable collar with seepage holes, and TYPE B “5” diameter polished nickel bronze light duty strainer.
15. Top Loading Classification: Light Duty.
16. Funnel: Not required.
17. Inlet Fitting: Not required.
18. Trap Material: Cast iron.

19. Trap Pattern: Standard P-trap.
20. Trap Features: Trap-seal primer valve drain connection.

B. Stainless-Steel Floor Drains FD-2: Kitchen Area Drains

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z1726-KC or a comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Watts Drainage Products Inc.
2. Standard: ASME A112.3.1.
3. Outlet: Bottom.
4. Top or Strainer Material: Stainless steel.
5. Top Shape: Round.
6. Seepage Flange: Required.
7. Anchor Flange: Required.
8. Clamping Device: Required.
9. Trap-Primer Connection: Required.
10. Trap Material: Stainless steel.
11. Trap Pattern: Standard P-trap.

C. Floor Sinks FS-1: Kitchen Area

1. Basis-of-Design Product: Product: Subject to compliance with requirements, provide Zurn No. Z1750-P or a comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Watts Drainage Products Inc.
2. Body: 12 x12 x6, 14 ga. Type 304 stainless steel
3. Grate: Provide 1/2 or 3/4 grate as indicated on plans.
4. Trap-Primer Connection: Required.
5. Clamping Device: Required.
6. Sediment Strainer: Required.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Portal Plus No. C-126 for NPS 2-6 and C-182 for NPS 89-12 or a comparable product by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Roof Products & Systems (RPS)

- B. Description: Manufactured assembly made of 0.60 thick spun aluminum base with double-beaded collar which forms a weather tight pressure seal with EPDM rubber cap and stainless steel clamps.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
 - b. Hilti
 - c. 3M
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains HUB-1:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.6 GREASE INTERCEPTORS

A. Grease Interceptors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Hill County Concrete Products.
 - b. Vaughn Concrete Products
2. Body Material: Concrete with heavy traffic lid.
3. Grease Retention Capacity: As indicated on plans
4. Inlet and Outlet Size: NPS 4
5. End Connections: Hub.
6. Cleanout: Integral or field installed on outlet.
7. Mounting: below grade with manhole collar extending 2 inch above finish grade.
8. Operation: Manual cleaning.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- F. Assemble open drain fittings and install with top of hub 1 inch minimum above floor.
- G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

- J. Install grease interceptors, including trapping, and venting, according to authorities having jurisdiction and with clear space for servicing.
- K. Install wood-blocking reinforcement for wall-mounting-type specialties.
- L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- M. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Grease Interceptors: Connect inlet and outlet to unit, and vent to unit inlet and outlet piping.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled grease interceptor and their installation, including piping and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust. Replace damaged and malfunctioning controls and equipment.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15155

**SECTION 15240
VIBRATION ISOLATION**

PART 1. GENERAL**1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1-General Requirements and referenced documents.
- B. Comply with all other Division 15 Sections, as applicable. Refer to other Divisions for coordination of work with other trades as required.

1.2 SYSTEM DESCRIPTION:

- A. A complete system of vibration isolation for all mechanical equipment to eliminate the transmission of noise and vibration within the building.

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 equipment and vibration isolation manufacturers.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's descriptive literature and installation instructions for all vibration isolation equipment.
- B. Shop Drawings: Submit in accordance with Section 15010.

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 be rejected.
- B. Storage and protection of materials shall be in accordance with Section 15010.

PART 2. PRODUCTS**2.1 GENERAL:**

- A. Objectionable vibration or noise created in any part of the building by the operation of any equipment furnished and/or installed under any portion of the Mechanical work will not be permissible.
- B. The Contractor shall take all precautions against the same by isolating the various items of equipment, pipes, and ducts from the building structure and by such other means as may be necessary to eliminate the transmission of excessive vibration and objectionable noise produced by any equipment installed by him.
- C. Consequently, he shall design all foundations, supports, etc., for his equipment and all piping and ductwork with this end in view.
- D. In addition, this Contractor shall supervise and/or instruct the construction of all foundations and supports, whether he builds them or not, in order that they may be

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VIBRATION ISOLATION**

constructed in such manner as to prevent the transmission of noise and/or vibration.

2.2 APPLICATIONS:

- A. Isolating material shall be selected in each case in accordance with the manufacturer's recommendations and the latter shall be prepared to demonstrate, upon request of the Architect, the isolation effectiveness of the material, which has been installed upon his recommendation.
- B. Isolators shall be so selected that when all the items in each of the mechanical rooms are in simultaneous operation, the vibration transmission to the building at the lowest disturbing frequency shall be limited to a maximum of 10% for a mechanical equipment room floor that is on the ground and 5% for all other building surfaces, including those in fan rooms, from all the equipment when the various items are in harmony.
- C. Isolators for supporting floor mounted equipment (where not internally isolated) shall be of the open spring type with ribbed pads bonded to the underside of the base plate. Similar to Amber Booth Type SW2 with a minimum 2-inch deflection.
- D. Isolators for supporting equipment suspended from the construction above on rod hangers, not internally isolated, shall be of the spring type with housings and noise washers, lock washers, nuts, etc. Similar to Amber Booth Type BSW1 or 2 with a minimum 1-inch deflection for fans and 2-inch deflection for air handling units.
- E. Each pipe connected to a floor mounted pump and to an item of equipment mounted on external vibration isolators shall have a sufficient number of spring hangers to permit compensation for movement of the piping and equipment, but in no case shall there be less than five (5) per pipe. These spring hangers shall also serve to dampen vibration transmission to the building. Provide other spring hangers for pipes, compensators, etc., as required to comply with the vibration transmission limits listed hereinbefore.
- F. Pumps shall be mounted on housekeeping pads and ribbed neoprene pads bonded to base plate equal to Amber Booth Ampad Type NRC, Style B isolators.
- G. Transformers shall be mounted on housekeeping pads and ribbed neoprene pad equal to Amber Booth Ampad Type Style B isolators.

2.3 MANUFACTURER:

- A. Isolating material used shall be equivalent to AmberBooth, Korfund, or Vibration Mountings.

PART 3. EXECUTION

3.1 PERFORMANCE OF ISOLATORS:

- A. Comply with recommendations set forth by the American Society of Heating, Refrigerating and Air Conditioning Engineers for the selection and application of vibration isolation materials and units.
- B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

SECTION 15240
VIBRATION ISOLATION

END OF SECTION

**SECTION 15250
INSULATION****PART 1. GENERAL****1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1 - General Requirements and referenced documents.
- B. Comply with all Division 15 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 foreman 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:

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INSULATION**

- 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 than 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 15010 - GENERAL 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 15010 - GENERAL PROVISIONS.

PART 2. PRODUCTS**2.1 GENERAL:**

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INSULATION**

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.

B. Insulation to be GreenGuard Certified. Include data sheet in submittal for review.

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, °F	500
Density, lbs./cf.	4.0 to 7.0
Specific Heat, BTU/lb./°F	0.20
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

B. Class II insulation shall be heavy density performed 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	0.25
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	0.25
90°F mean temperature	0.25
Water Vapor Permeability	0.1

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

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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.

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- 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		0.75 to 1.5
Thermal Conductivity, BTU/Hr/°F/sq. ft.		0.25

- 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 3
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.	0.24	

- F. Grease Duct Wrap:

Grease ducts to be wrapped per requirements of NFPA 96, UBC, UMC, SBC for 1- and 2-hour enclosures. Duct wrap to be similar to Premier Refractories Pyroscat FP fire barrier, duct wrap, 1-1/2" thick per 1-hour requirement. Requirement of 1-hour or 2-hour to be per local code authority. Insulation to meet requirements of UL 263, UL 723, UL 1479, UL 1978, ISO6944, UL-C FRD 6. Wrap to be listed for zero clearance. Install per UL listings and manufacturer’s recommendations.

GENERAL NOTE: All internally applied liner shall include an anti-microbial agent Adhered to the liner.

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

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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 pipelines 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 40EF. Insulation applied or cured in ambient temperatures below 40EF. 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.

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- 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:

PIPE SIZE	METAL SADDLES	
	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. Fiberglass 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 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.

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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)

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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, seams and penetrations shall be sealed with an approved mastic reinforced with three inches of glass mesh reinforcement, or three inches foil/vapor-barrier tape. Where insulation terminates, raw glass shall be sealed to duct. Fiberglass insulation to incorporate a vapor barrier jacket outside the insulation.

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.

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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 airflow 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.
- D. Grease Duct Wrap:
1. Installation to be per UL listing and manufacturer's recommendations. When duct width or height is 18" or wider, use pins and clips on bottom of duct evenly spaced 8-to-12" apart from each other on all vertical duct sections, sides and bottoms. At overlaps, install pins and clips per manufacturer. Access doors to be installed with two metal access door plates, threaded studs welded around perimeter and sealed CLK Firestop Sealant, three layers of Pyroscat FP Duct Wrap and 2-mil aluminum foil tape, all per manufacturer's recommendations. Floor and wall penetrations to be per manufacturer's recommendations. Repair damaged duct wrap, rod penetrations, etc., per manufacturer's recommendations.
- E. Ductwork Exposed To Weather:
1. Insulate the ductwork with high density rigid insulation, 3" thick, with sloped top (minimum 1/2" per foot) coated with continuous glass fab, Benjamin Foster exterior mastic similar to Selfas GPM 35-00, white, with final covering of 0.024-inch thick aluminum jacketing, with seams on bottom of duct, and all joints sealed weathertight per manufacturer's

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recommendations. Aluminum jacketing to be self-fastening, Type 3003-H14 aluminum alloy.

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 <u>Service</u>	<u>Class</u>	<u>Insulation Thickness</u>
	Domestic Cold Water Piping	II	1"
	Domestic Hot Water Piping	II	1"
	Condensate Drain Piping **	III	1/2"
	Cold Drain Piping (Including Floor Drains)	I	1/2"
	Horizontal Storm Drain Piping-Parking Garages (Including Roof Drains & Bowls)	I	1-1/2"
	Horizontal Storm drain Piping (Bldg. Interior) Including Roof Drains & Bowls	I	1"
	Chilled Water and Condenser Supply and Return Piping	I	2"- Pipe sizes 21/2" & larger
	Heating Water Supply and Return Piping	II	1-1 /2" pipe sizes and smaller
	Condenser water piping above Conditioned spaces	N/A	2" None

B. Ductwork: ***

<u>Insulation Service</u>	<u>Class</u>	<u>Insulation Thickness</u>
Supply Air Duct	A	2"
Return Air Duct	A	2"
Supply Air Duct within (First 12'-0" of horizontal duct and unit drops)	B	1 ½ "

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Return Air Duct within
(First 12'-0" of horizontal duct
and unit drops)

B

1 ½ "-2#
2"-3# in noise
sensitive areas

Outside air Duct on roof *

C

3"-4.25#

* Insulation material to be Manville 800 spin glass with aluminum foil reinforced Facing.
Cover entire assembly with aluminum jacketing as indicated in section 15250-2.2g.

** Condensate drains on roof to be non-insulated type M- copper.

*** Liner attached to the interior of any ductwork or equipment serving a facility that
being utilized as or is classified as a medical facility is absolutely prohibited.
Externally applied insulation is permissible using the above chart and
specifications.

END OF SECTION

**SECTION 15301
FIRE PROTECTION****PART 1. GENERAL****1.0 SCOPE**

- A. This section specifies a complete and working fire protection system consisting of an automatic wet pipe fire sprinkler system and an automatic dry pipe fire sprinkler system.
- B. Furnish a complete, engineered (sealed) and approved (by the City of Houston and a Licensed Professional Engineer registered in the State of Texas) design of the building automatic fire sprinkler system. Design shall include the entire building.
- C. The design shall be thoroughly coordinated with the Architect. It is a requirement of this section to obtain approval for each pipe run and sprinkler head. The design of the sprinkler system shall be accomplished with the full approval of the Architect. Close and thorough coordination is required. See requirements found elsewhere in this section

1.1 SECTION INCLUDES:

- A. Fire Service Mains.
- B. Wet Sprinkler System.
- C. Dry Sprinkler System
- D. Alarm and signal devices.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION:

- A. Concrete Formwork: Placement of pipe sleeves, supports and anchors – Division 1.

1.3 RELATED SECTION:

- A. Pipe and Pipe Fittings
- B. General Provisions
- C. Basic Materials and Methods
- D. Mechanical Systems Demonstrations
- E. Fire Alarm

1.4 REFERENCES:

- A. AWS D10.9 – Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing, level AR-3.
- B. NFPA 13 – Fire Sprinkler Systems

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- C. 2000 International Fire Code
- D. Make the installation in accordance with applicable statutes, ordinances, codes and regulations of National Fire Protection Association (NFPA), Underwriters Laboratories (UL), Texas State Board of Insurance, OSHA, the building insurance underwriter, the City of Houston Fire Department and any state, local or other governmental authorities having jurisdiction.

1.5 SYSTEM DESCRIPTION:

- A. Design Criteria:
 - 1. Where there is conflict between local authority requirements or other standards agency requirements and these Drawings and specifications, requirements of standards agencies of local authorities shall govern.
 - 2. Design and install entire system(s) in accordance with indicated codes standards and regulations.
 - 3. Calculations shall be based on a current flow test from hydrants closest to the site.
 - 4. Contractor shall coordinate with Local Fire Department to obtain or witness flow test.
 - 5. Fire Sprinkler calculations shall have a 10% safety margin based on the flow test information.
 - 6. Do not downsize piping indicated to serve future areas.
 - 7. Drawings are diagrammatic only to indicate rooms/areas of protection.
 - 8. Requirements. Provide a complete, working and approved automatic sprinkler system for the entire building, including all concealed spaces, attics, stairs and outside covered walkways as required by all authorities listed in this Specification. Provide a complete automatic wet pipe sprinkler system for all heated building areas and a complete dry pipe system for all unheated areas (areas subject to freezing). All portions of buildings shall be protected by automatic fire sprinkler systems. Reference floor Drawings for additional requirements. Drawings indicate a general arrangement of the system and are not to be considered as a complete or final design. If Contractor must deviate from general arrangement shown, such deviation shall be clearly indicated with Contractor's bid and shall submit a detailed description of the deviation with his bid. Contractor shall pay all costs incurred to change the sprinkler system design or arrangement after award of Contract.
 - 9. System Design. The sprinkler system Contractor is required to develop, submit and install a complete and approved fire protection system design.
 - 10. Prepare detailed Drawings and submit them to Factory Mutual, the building insurance underwriter, the Texas State Board of Insurance, the City of

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Houston Fire Marshall's Office, and any other state or local governing body having jurisdiction for approval. Contractor shall commence design Work on submittal Drawings immediately after award of Contract and shall submit approved Drawings to the Architect in a reasonable amount of time (for Engineer's acknowledgment) prior to installation of any portion of the fire systems. Approved data shall bear seal of approval by the Texas State Board of Insurance, Factory Mutual Industrial Risk Insurer's, the City of Houston Fire Department and all other agencies having jurisdiction (insurance or otherwise). Submit approved Drawings only. Do not submit Drawings to Architect without approval seal and signature. Drawings shall include all required information required by NFPA pamphlets for working Drawings, including all details, Drawings, calculations, etc. All fire sprinkler Drawings shall include all information required by NFPA 13, Chapter 1.

11. Drawings shall be submitted to governmental authorities (listed in this Specification), for approval immediately after award of Contract to avoid delays on the Construction project. Contractor shall be responsible for obtaining approvals before start of Construction and shall assume all responsibilities for delays.
12. The Contractor shall be responsible for the complete design of the fire sprinkler system. All pressure losses thru the distribution system and fluctuations in supply system pressures shall be adequately accounted for. Care shall be taken in making water tests to be used in designing or evaluating the capacity of sprinkler systems. Reference NFPA pamphlet No. 13 Appendix A. It shall be the sole responsibility of the Contractor to replace or otherwise correct any portion of the fire sprinkler system that does not meet available pressures and flow rates. Future changes in water supplies shall be considered. It shall be the sole responsibility of the Contractor to determine available flow and pressures.
13. The automatic sprinkler system shall be hydraulically designed (by the Contractor).
14. All piping shall be installed above finished ceilings and below roof insulation (except for dry pipe systems). Do not route piping under lights.
15. Provisions for flushing systems. Sprinkler system shall be arranged for flushing. Readily removable fittings shall be provided at the end of all cross mains. All cross mains shall terminate in 1-1/4 inches or larger pipe. All branch lines on sprinkler system shall be arranged to facilitate flushing. Route all drain lines to outside.
16. Contractor shall coordinate exact location of access doors with Architect during design phase. Obtain location approval from Architect for each and every access door.
17. All sprinkler heads shall be installed at the center of all ceiling tiles. Do not locate heads off center of tiles or near ceiling grids. Contractor shall include in his bid costs for additional pipe, sprinkler heads, etc. required to accomplish these spacing requirements.

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18. Prior to installation, provide a minimum of seven (7) copies of approved Drawings to the Architect. Do not start installation Work until all required approvals have been obtained.

1.6 SUBMITTALS:

- A. Procedures for Submittals: Reference Division 1
- B. Product Data
 1. Catalog cuts
 2. Performance data
- C. Shop Drawings:
 1. Complete layout of fire protection system approved by all agencies having jurisdiction.
 2. Include flow calculations
- D. Contract closeout information:
 1. Operating and maintenance data.
 2. Owner instruction report.
 3. Test reports:
 - a. Certification that all tests as indicated in paragraph Field quality Control have been successfully completed and approved by all authorities having jurisdiction.
 - b. Provide test report for each building and site distribution system as required by NFPA.
 4. Guarantees/Warranties.
- E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- F. Welders Certificate: Indicate compliance with AWS D10.9.

1.7 QUALITY ASSURANCE:

- A. Installer's Qualifications: Licensed as a fire protection systems installer in the State of Texas for a minimum of three years with a five project history of similar size and scope. Qualify welding processes and welding operators in accordance with AWS D10.9.
 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes invoiced and, if pertinent, has undergone recertification.
- B. Manufacturer's Qualifications: All products shall be UL or FM listed.

**SECTION 15301
FIRE PROTECTION****C. Regulatory Requirements:**

1. Make installation in accordance with applicable requirements of National Fire Protection Association (NFPA) pamphlets and any requirements of state or local authorities.
2. NFPA 13 – Fire Sprinkler Systems
3. NFPA 24 – Thrust Blocks
4. Owner's insurance requirements.
5. 2000 International Fire Code
6. Local Fire Marshal's requirements

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Products specified are manufactured by Mason Industries [Amber-Booth, Co.] and are listed as a standard or quality.
- B. Products of the following manufacturers are acceptable subject to meeting specification requirements and the approval of Local Authorities and Governing Standards:
 1. Viking
 2. Anvil
 3. Grinnell
 4. Potter Roemer
 5. Elkhart
 6. Vibration Mounting and Controls
 7. Substitutions: per approval only

2.2 PIPE AND FITTINGS:

- A. Fire system piping above ground:
 1. Provide Schedule 40, black steel pipe conforming to ASTM B 53 with Class 150 standard Malleable Iron screwed fittings. s black steel, Schedule 40 for sprinkler piping. No Schedule 10 thinwall piping allowed. No Dyna Flow pipe will be approved.
 2. Joints: Welded, threaded or mechanical joints, with malleable iron couplings. Equal to Gruvlok or Victaulic.

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3. Fittings: Steel for welded joints or minimum 250-psi threaded fittings, cast or malleable iron. Equal to Gustin-Bacon or Victaulic.
 4. Mechanical joint fittings: Black malleable iron, roll or cut grooved.
 - a. Do not cut groove pipe less than Schedule 40.
 - b. Not acceptable in walls or concealed.
 5. Generally, use threaded joints and fittings for piping 2 inches and smaller and welded or mechanical joints for piping larger than 2-1/2 inches.
- B. Fire System below grade beyond 5'0" from building line: Reference Civil Documents.
- C. Fire System below slab and grade within 5'-0" of building line, ductile iron.
1. Provide Class 50 ductile iron pipe meeting requirements of AWWA C 104, C 151 and ASTM A 339, wrapped with at least 8 mils of polyethylene wrap. Provide concrete thrust blocks at all changes in direction, according to the pipe manufacturer's recommendations (minimum 4 sack mix with a compressive strength at 28 days of 2000 PSI).
- D. Pipe painting:
1. Paint red and label all fire sprinkler piping.

2.3 GENERAL DUTY VALVES:

- A. General: Conform to the requirements of NFPA-13 and NFPA-14.
- B. Provide valves for use on fire mains as specified. Valves 2-1/2" inches and above must be stamped with FM and/or UL approval. Comply with Section 15050. Minimum 175 psi working pressure. Refer to Part 3 for application and schedule.
- C. Gate Valves: Provide Stockham No. G-634, iron body wedge gate valve, or approved equal, with 175 psig working pressure. Equip with a supervisory switch as specified in Division 16-Electrical. For post indicators valves, provide Stockham No. G-635 iron body gate valves, Provide Stockham No. G-950 wall indicator post or No. G-951 vertical indicator post as required.
- D. Check Valves: Provide Stockham No. G-939, iron body swing check valve, or approved equal, with 175 psig working pressure.
- E. Alarm Valve Assemblies: Provide approved alarm valves, 175 LBS rated pressure complete with all variable pressure trim, valves, etc., as required.
- F. Sectional Valves: Provide indicating iron gate control valve, outside-screw-and-yoke (OS&Y), 175 LB rated working pressure, of size and end types indicated: 2" and smaller: Jenkins 275U, Crane 450 or Walworth 873. 2-1/2" and larger: Jenkins B25A, Crane 467, Walworth 8723F, or Demco Series NEH. 2" to 12": Hub end gate (AWWA) Mueller 2380-5.

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- G. UL or FM approved butterfly valves with integral tamper switch may be used in place of gate valves.
- H. Indicator post: 2 piece indicator post for non-rising stem gate valve, target plate OPEN and SHUT, 5 inch sleeve; Gem 1430.

2.4 AUTOMATIC SPRINKLERS:

- A. Fire Sprinklers: Provide standard bulb-type automatic fire sprinklers with 165 Deg.F., or as required by NFPA-13, operating temperature of the following style and finish:
Sprinkler Style:
 - 1. Provide upright pendent type with cage guard equal to central Model GB in areas without ceilings. Sprinkler head finish shall be rough brass in non-occupied areas and polished chrome in occupied or finished areas.
 - 2. Provide concealed pendent type with factory painted "Of-White" cover plate equal to Central Adjustable Royal Flush Concealed sprinkler head model AA in areas with ceilings.
 - 3. Provide upright extra large orifice quick response sprinkler heads in areas with flammable liquids such as the spray paint area.
 - 4. Sprinklers in non-heated outside storage rooms, covered loading dock, walk-in coolers and freezers shall be Central Model "H-1" upright pendent or recessed. Provide length as required to keep wet section of piping in heated space. Equivalent sprinkler heads by Reliable will be acceptable.
- B. Emergency Head Storage Cabinet:
 - 1. Provide a red, baked enamel, steel sprinkler cabinet to store the extra sprinklers and wrenches as required by NFPA-13.

2.5 FIRE SYSTEM SPECIALTIES:

- A. Outside valve boxes:
 - 1. 3 piece cast iron, extension type, 5-1/4 inch shaft, 5-1/4 inch drop lid, screw or slip type.
 - 2. Screw type lid: Tyler 6860 with no. 6 bell base.
 - 3. Slip type lid: Tyler 6865 with No. 8 bell base.
 - 4. Mark kids with WATER cast in metal.
- B. Backflow preventers: Provide as specified in Section 15411.
 - 1. U/L and FM approved.
 - 2. Comply with City Standards and Specifications

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- C. Pressure Gauges: Provide 3-1/3 inch diameter, Allenco No. 1700 pressure gauges with stainless steel case and with a range of 0-300 psig, include gauge cock.
- D. Water-Motor Gong: Provide 10: weatherproof, red enameled finished, water-motor gong as indicated.
- E. Hangers and Supports: Provide hangers and supports as required by NFPA-13.

2.6 FIRE DEPARTMENT (3-WAY) CONNECTIONS:

- A. Fire department 3-way connections:
 - 1. Outside type
 - 2. Size: 4 x 2-1/2 x 2-1/2 x 2-1/2 inches, unless otherwise indicated.
 - 3. Finish: Polished Chrome.
 - 4. Lettering: Standpipe fire Department connection as appropriate.
 - 5. Exposed wall connections:
 - a. Triple clapper, 3-way bode, escutcheon plate with lettering, caps and chain.
 - b. Potter-Roemer 5740-B.
 - 6. Free standing connections:
 - a. Brass sleeve, escutcheon plate with lettering, caps and chain.
 - b. Potter-Roemer 5771-B.
 - 7. Separate wall plate designating special service:
 - a. Finish same as Siamese, anchored to wall
 - b. Provide at each location.
 - c. Potter-Roemer 5960
- B. Automatic ball drip valve:
 - 1. Straight or angle cast brass ball drip, 1/2 IN.
 - 2. Mount on Siamese side of check valves.
 - 3. Potter-Roemer 5981.

2.7 ALARM AND SIGNAL DEVICES:

- A. Water flow detectors:

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1. Vane type flow switch with retard mechanism or manual adjustment to prevent false alarm.
 2. 175 psi rated
 3. 115 VAC rated for pilot duty only
 4. Suitable for working pressure of 150 psi with sensitivity adjusting screw.
 5. Provide with contacts for remote signal wiring.
 6. Simplex 2097 Series or Notifier WFD (wet).
 7. Provide separate contacts for fire alarm systems.
- B. Valve tamper switch
1. 115 VAC/30 V DC
 2. Switches for butterfly valves: Approved type.
 3. Simplex 2097-9031 or Notifier NGV (OS & Y valve), NIP (post indicator valve) supervisory switch.
- C. Fire alarm system control panel: Provided under Division 16.

PART 3. EXECUTION**3.1 PREPARATION:**

- A. Comply with the requirements of NFPA 14 for standpipe and hose systems, and NFPA 24 for fire service mains for installation and testing or piping system.
- B. Review plans, specifications and shop drawings of entire Project to coordinate Work. Ensure adequate space for equipment and piping placement for all systems that must be installed in shared spaces.
- C. Protection During Construction: Provide necessary fire protection during construction in accordance with NFPA and Local Codes.
- D. Install in strict accord with approved shop drawings.
- E. Install all piping, and connections from city mains to building fire protection systems in accordance with Local Authorities and City Standards specifications.
- F. Do not begin installation until all Agency approvals are submitted to Architect.

3.2 INSTALLATION OF PIPING, VALVES AND ACCESSORIES:

- A. General: Comply with the requirements of NFPA No. 13 "Standards for the Installation of Sprinkler Systems", NFPA No. 14 "Standard for the Installation of Standpipe and Hose Systems," and NFPA No. 24 "Standard for the Installation of Private Fire Service Mains and Their Appurtenances" for installation, testing and anchoring or piping system.

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- B. Service entrance to buildings: Install flange for main shut off valve square and true within first 3 feet after penetrating building wall or foundation. Provide sleeve and mechanical link seal at below grade wall or beam penetrations. Transition from below grade outside piping to interior piping using approved transition fittings with anchor rod fasteners to prevent separation.
- C. Install Fire Protection System piping within first 6 inches of space under floor or below roof construction:
 - 1. Where conditions of construction require piping installation at a lower elevation, route piping to avoid interference with work of other trades.
 - 2. Offset, crossover and otherwise route piping to install system in available space.
 - 3. Not all offsets are shown.
 - 4. Pitch all branch lines, cross mains, feed mains and risers to drainage points.
 - 5. Provide permitted at offsets when approved by local authority.
- D. Hangers and supports: Comply with NFPA 13 and 14, Section 15050.
- E. Provide OS & Y valve and drain valve at base of all standpipes.
 - 1. Install flow switches
- F. Provide OS & Y valve and flow switch within system at each of following locations:
 - 1. Each zone takeoff within sprinkler piping system.
 - 2. Each sprinkler branch takeoff from fire hose standpipe within combination sprinkler standpipe system.
 - 3. Base of all sprinkler risers.
- G. Install tamper switch on each OS & Y or butterfly valve within system, including valve assembly at sprinkler control, base of standpipes, sprinkler zone and isolation valves and post indicator valve.
- H. Provide auto ball drip valves at outside fire department connections between hose connection and check and shutoff valve.
- I. Install fire department standpipe valves at height required by local authorities.
 - 1. Position valve to allow 12 inch spanner wrench clearance for connecting hose.
- J. Flush Outside fire water mains prior to connecting to inside system.
- K. Provide wall flange at each FDV and within FHC boxes when risers are concealed.

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- L. Provide valve boxes at each outside (underground) valve per city standards and specifications.
- M. Install indicator posts approximately 3 feet above grade.
- N. Install pressure gages at top of each standpipe hose rack assembly and sprinkler riser and elsewhere as required by local authority.
- O. Paint all piping red and label in accordance with Sections under Division 1. provide signage for alarm valves and accessories per NFPA.
- P. Conceal all piping in finished areas. Do not run exposed piping in Cells, Sallyports or Day Rooms or other areas as indicated on Drawings.
- Q. Use only NFPA approved fittings to make changes in direction, branch take offs, and reductions in size.

3.3 ELECTRICAL WIRING:

- A. Fire alarm system installer provides
 - 1. Supervised wiring from main water flow indicator to fire alarm panel.
 - 2. Supervised wiring from sprinkler flow switches to fire alarm panel.
 - 3. Supervised wiring from valve tamper switches to fire alarm panel.
- B. Fire protection system installer responsible for providing wiring diagrams for all devices.

3.4 FIELD QUALITY CONTROL:

- A. Responsibility: The Fire Protection System Contractor shall be the responsible contractor for the installation, testing and certification of the entire "on-site" underground fire protection water main distribution system from the connection to the public water source (off-site) to all fire hydrants, to all buildings fire protection systems. This contractor shall jointly coordinate the installation of the underground water distribution service with the general contractor and the related work of the site utility contractor and the plumbing contractor. The aforementioned requirements shall not relieve the responsibility or liability for the integrity, conformance to code requirements, installation, performance, or warranty of their respective work and/or systems.
- B. Protection During Construction: Provide necessary fire protection during construction in accordance with NFPA and Local Codes.
- C. Inspection and Tests: All inspections, examinations, and test required by the authorities and/or agencies specified hereinbefore shall be arranged and paid for by the contractor, as necessary, to obtain complete and final acceptance of the system as installed. The certificates of inspection shall be in quadruplicate, and shall be delivered to the Architect for distribution.
- D. Test standpipe piping, including outside supplies, under hydrostatic pressure to 200 PSI for 2 hours.

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1. Prove system tight to satisfaction of Architect.
 2. Inside piping to show no leakage
 3. Leakage in underground piping in accord with NFPA 24.
- E. Test complete alarm system including control and signal circuits.
1. Coordinate with fire alarm installer
 2. Complete testing prior to acceptance by Owner.
- F. Thread Test: Test threads on 2-1/2 inch valves, using a coupling from the local fire department hose. Make the test in presence of the Architect.
- G. Give advance notice and arrange for field tests and inspections by local authority.

END OF SECTION

**SECTION 15354
HOOD FIRE PROTECTION SYSTEM**

PART 1. GENERAL**1.1 GENERAL:**

- A. Section 15010 - GENERAL PROVISIONS FOR MECHANICAL WORK is hereby made a part of this section.

1.2 SCOPE:

- A. Furnish all labor, materials, tools, equipment and related items required for the complete installation of Hood Fire Protection Systems as indicated by the Contract Documents.
- B. In each kitchen area, install wet chemical extinguishing systems in all range hood. System shall be UL listed and shall comply in all respects with NFPA No. 17 and No. 96, all applicable codes, and the requirements of the Owner's insurance carrier.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

- A. Fire Alarm System - Section 16722

1.4 SUBMITTALS:

- A. Submit for approval on Hood Fire Protection Systems.

PART 2. PRODUCTS**2.1 DRY CHEMICAL SYSTEM:**

- A. Provide Ansul or Kidde R-102, automatic wet chemical extinguishing systems, each providing the following principal features:
1. Automatic detection and actuation by fixed temperature mechanical.
 2. Remote manual actuation that operates entirely independent of automatic releases.
 3. Integral manual actuation at the cylinder valve.
 4. Pressure switch shut-down of electrical cooking equipment.
 5. Pressure release of natural gas supply valves.

2.2 CYLINDERS:

- A. Cylinder assemblies shall be of required capacity and shall conform to regulations of the D.O.T. Cylinders shall be fitted with a pressure seat type valve. Cylinders shall be stored in steel racks designed to hold the cylinders securely in an upright position with clamps or straps. The arrangement of cylinders in the rack shall be such as to require the least floor space, including service aisles and shall be suitable for wall mounting. A common mounting bracket for multiple systems, regardless of cylinder size, shall be supplied.

2.3 VALVE ASSEMBLIES:

**SECTION 15354
HOOD FIRE PROTECTION SYSTEM**

- A. Cylinders shall be fitted with a resilient pressure seat type valve. It shall incorporate a fusible safety, which will relieve the contents within the system at 275 deg. F. A waterproof gauge shall be fitted in the valve body, which indicates at all times whether the system is operable.

2.4 CONTROLS:

- A. The system shall be released automatically if the temperature in the hazard reaches the pre-determined setting. Melting of the fusible link type element shall cause the cylinder valve to discharge.
- B. A remote manual release finished on all sides shall be located accessibly near the hazard and piped to the cylinder valve. The valve, when operated, shall discharge wet chemical from the cylinder(s) to the distribution system.
- C. A means of manually releasing the system at the cylinder(s) shall be provided which overrides all other means of actuation.
- D. Discharge of the system shall automatically shut off gas and electricity to all cooking equipment.

2.5 DISTRIBUTION SYSTEM:

- A. The wet chemical shall be discharged through nozzles in the hazard. The nozzles shall be sized and located to provide the rates of discharge and coverage as established by the system rating as covered by the system listing. The size of pipe and nozzles shall be determined on the basis of pre-calculated flow. Flow and nozzle data shall be determined on the basis of pre-calculated flow. Flow and nozzle data shall be in accordance with standards approved by Underwriters' Laboratories and Factory Mutual. Nozzles shall be fabricated of corrosion-resistant materials or shall be furnished with a protective coating.

2.6 ACCESSORIES:

- A. Pressure Switch: Each system shall include two (2) normally-open and two (2) normally-closed contacts to actuate building fire alarm system and to trip circuit breakers with shunt trip units. Switches shall be heavy duty double-pole, single-throw, two to a unit. The assembly shall include a manual operator for start and reset. Pressure switches shall be installed in the distribution piping in such manner as to assure operation under all means of system release, unless otherwise specified.
- B. Pressure Release: Each system shall include one (1) pressure trips to release fuel shut-off valve.
- C. Shut-Off Valve: Each system shall include a normally-open weight-operated valve in the low pressure natural gas supply line to cooking equipment under the hood. The valve shall close when the system discharges and shall require a manual reset.
- D. Cover: The cylinder(s) and valve(s) shall be protected by means of full enclosure. The cover shall have a stainless steel finish.

PART 3. EXECUTION

3.1 INSTALLATION:

**SECTION 15354
HOOD FIRE PROTECTION SYSTEM**

- A. All installation work shall be performed by certified installers.
- B. Installation shall be coordinated with supplier of range hoods so that a neat, workmanlike installation results.
- C. Mechanical Installation shall include setting up and mounting all system equipment connected to the piping; pipe and fittings, including necessary hangers and brackets, and all non-electrical elements of the control system in accordance with the manufacturer's installation instructions. Contractor shall provide the material and labor to connect system pressure releases to valves, etc. being released.
- D. Electrical installation under Division 16 shall include mounting electrical components and wiring to system switches.

3.2 INSTRUCTIONS:

- A. Each system shall include permanent type nameplates and condensed instruction plates to identify the system and instruct on its use under emergency conditions. Three (3) copies of operating and maintenance instructions shall be provided.

3.3 ACCEPTANCE TESTS:

- A. Seller shall provide a technician to inspect the completed installation and to supervise the acceptance test. Tests shall include actuation of the cylinder valve, when fitted with the appropriate test fixture to prevent discharging of the dry chemical agent.

END OF SECTION

SECTION 15410 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories and sinks.
 - 2. Flushometers.
 - 3. Toilet seats.
 - 4. Protective shielding guards.
 - 5. Fixture supports.
 - 6. Water closets.
 - 7. Urinals.
 - 8. Lavatories.
 - 9. Kitchen sinks.
 - 10. Service basins.
- B. Related Sections include the following:
 - 1. Division 10 Section "Toilet and Bath Accessories."
 - 2. Division 15 Section "Emergency Plumbing Fixtures."
 - 3. Division 15 Section "Drinking Fountains and Water Coolers."
 - 4. Division 15 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- C. FRP: Fiberglass-reinforced plastic.
- D. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. LEED Submittal:
 - 1. Product Data for Credit WE 3.1 and 3.2: Documentation indicating flow and water consumption requirements.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Regulatory Requirements: Comply with requirements in Texas department Licensing & Regulation "Texas accessible Standards" for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Texas commission of Environmental Quality, "Water conservation Program," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
 - 2. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 3. Vitreous-China Fixtures: ASME A112.19.2M.
 - 4. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
- G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Faucets: ASME A112.18.1.
 - 2. Hose-Connection Vacuum Breakers: ASSE 1011.

3. Hose-Coupling Threads: ASME B1.20.7.
 4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 5. NSF Potable-Water Materials: NSF 61.
 6. Pipe Threads: ASME B1.20.1.
 7. Supply Fittings: ASME A112.18.1.
 8. Brass Waste Fittings: ASME A112.18.2.
- H. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1.
 3. Manual-Operation Flushometers: ASSE 1037.
 4. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Flexible Water Connectors: ASME A112.18.6.
 2. Floor Drains: ASME A112.6.3.
 3. Hose-Coupling Threads: ASME B1.20.7.
 4. Off-Floor Fixture Supports: ASME A112.6.1M.
 5. Pipe Threads: ASME B1.20.1.
 6. Plastic Toilet Seats: ANSI Z124.5.
 7. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

PART 2 - PRODUCTS

2.1 TOILET SEATS

A. Toilet Seats,:

1. Manufacturers: Subject to compliance with requirements, provide Zurn or by one manufacturer offering products that may be incorporated into the Work include, by the following:
 - a. Bemis Manufacturing Company.
 - b. Church Seats.
2. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic.
 - b. Configuration: Open front cover.
 - c. Size: Elongated.
 - d. Hinge Type: CK, check.
 - e. Class: Heavy-duty commercial.

- f. Color: White.

2.2 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, PC-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z5650 or a comparable product by one of the following:
 - a. TRUEBRO, Inc.
 - b. McGuire Manufacturing, Inc.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.3 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide Zurn products or by one of the manufacturer offering products that may be incorporated into the work include the following:

1. As specified.
2. MIFAB Manufacturing Inc.

B. Urinal Supports,:

1. Description: Type II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

C. Lavatory Supports,:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.4 WATER CLOSETS

A. Water Closets, HWC-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide ZURN No. Z5655 or a comparable product by one of the following:
 - a. American Standard Companies, Inc. No. 2234.015
 - b. Kohler Co. No. K-4349
2. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.

- a. Style: Flushometer valve.
 - 1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
 - 2) Height: Accessible Child.
 - 3) Design Consumption: 1.28 gal./flush.
 - 4) Color: White.
 - b. Flushometer: Zurn No. ZTS6200EV, battery operated – base bid.
 - c. Toilet Seat: Zurn No. Z5955SS-EL, elongated open front seat.
 - d. Rim height: 14 inch A.F.F.
 - e. Closet blot & wax ring: Oatey No. 42256 with No. 42759 gasket
3. Alternate Bid: Provide Zurn No. Z5650 water closet with Zurn No. Z6000AV-WS1 manual flush valve.
- B. Water Closets, HWC-2:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z5665 or a comparable product by one of the following:
 - a. American Standard Companies, Inc. No. 3043.102
 - b. Kohler Co. No. K-4368
 2. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.
 - a. Style: Flushometer valve.
 - 1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
 - 2) Height: Accessible.
 - 3) Design Consumption: 1.28 gal./flush.
 - 4) Color: White.
 - b. Flushometer: Zurn No. ZTS6200EV, battery operated.
 - c. Toilet Seat: Zurn No. Z5995SS-EL, elongated open front seat.
 - d. Top of rim height: 17 inch A.F.F.
 - e. Closet blot & wax ring: Oatey No. 42256 with No. 42759 gasket
 3. Alternate Bid: Provide Zurn No. Z5660 water closet with Zurn No. Z6000AV-WS1 manual flush valve.
- C. Water Closets, WC-1:
1. Basis-of-Design Product: Same as ‘HWC-1’
- D. Water Closet, WC-2:
1. Basis-of-Design Product: Same as “HWC-2”.

2.5 URINALS

A. Urinals, HUR-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z5738 or a comparable product by one of the following:
 - a. American Standard Companies, Inc. No. 6541.132
 - b. Kohler Co. No. K-5016-ET
2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
 - a. Type: Siphon jet with extended shields.
 - b. Trapway: Integral cast strainer with integral trap.
 - c. Design Consumption: 0.5 gal./flush.
 - d. Color: White.
 - e. Supply Spud Size: NPS 3/4.
 - f. Outlet Size: NPS 2.
 - g. Flushometer: Zurn No. Z5738205.00, 0.025 gpf.
 - h. Fixture Support: Urinal, Zurn No. Z1222 chair carrier.
 - i. Height: Accessible, Child- Verify mounting height with architectural drawings.
3. Alternate Bid: Provide Zurn No. 5730 with Zurn No. Z6003-AV-EWS, 0.5 gpf

B. Urinals, HUR-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z5730 or a comparable product by one of the following:
 - a. American Standard Companies, Inc. No. 6541.132
 - b. Kohler Co. No. K-5016-ET
2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
 - a. Type: Siphon jet with extended shields.
 - b. Trapway: Integral cast strainer with integral trap.
 - c. Design Consumption: 0.5 gal./flush.
 - d. Color: White.
 - e. Supply Spud Size: NPS 3/4.
 - f. Outlet Size: NPS 2.
 - g. Flushometer: Zurn No. Z6003-AV-EWS, 0.5 gpf.
 - h. Fixture Support: Urinal, Zurn No. Z1222 chair carrier.
 - i. Height; Accessible, Adult- Verify mounting height with architectural drawings.

C. Urinals, UR-1:

- a. Basis-of-Design Product: Same as type “HUR-1”.

2.6 LAVATORIES

A. Wall mounted Lavatories, L-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z5311 or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
2. Description: Accessible, wall-mounting, vitreous-china fixture.
 - a. Type: Ledge back.
 - b. Size: 20 by 18 inches rectangular.
 - c. Faucet Hole Punching: Three hole, 4-inch centers.
 - d. Faucet Hole Location: Top.
 - e. Color: White.
 - f. Faucet: Zurn No. Z86300-CP4-PT-G, slow closing metering faucet with 4” chrome plated cover, 1-1/4 NPS grid drain and 1-1/4 NPS tubular cast brass P-Trap.
 - g. Supplies: Watts No. FS-CFS-S series braided stainless steel faucet supply.
 - h. Drain: See faucet.
 - i. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, tubular brass waste to wall; and wall escutcheon.
 - j. Protective Shielding Guard(s): PC-1
 - k. Fixture Support: Lavatory Type II.

B. Wall mounted Lavatories, L-2

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z5314 or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
2. Description: Accessible, wall-mounting, vitreous-china fixture.
 - a. Type: Ledge back.
 - b. Size: 20 by 18 inches rectangular.
 - c. Faucet Hole Punching: Two hole.
 - d. Faucet Hole Location: Top.
 - e. Color: White.
 - f. Faucet: Zurn No. Z81000-XL-G-PT-EXT-3M, Single lever handle with grid drain, 1-1/4 cast P-Trap, rated at 0.5 gpm
 - g. Supplies: Watts No. FS-CFS-S series braided stainless steel faucet supply.
 - h. Angle Stop: Brass-Craft angle supply stop with wheel handle.
 - i. Drain: See faucet.
 - j. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, tubular brass waste to wall; and wall escutcheon.
 - k. Protective Shielding Guard(s): PC-1

- C. Fixture Support: Lavatory Type II.
- D. Counter mounted Lavatories, L-3:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z5114 or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
 - 2. Description: Counter-mounting, vitreous-china fixture.
 - a. Type: Self-rimming.
 - b. Oval Lavatory Size: 20 by 17 inches.
 - c. Faucet Hole Punching: Three holes, 4-inch centers.
 - d. Faucet Hole Location: Top.
 - e. Color: White.
 - f. Faucet: Zurn No. Z86300-CP4-PT-G, slow closing metering faucet with 4” chrome plated cover, 1-1/4 NPS grid drain and 1-1/4 NPS tubular cast brass P-Trap.
 - g. Supplies: Watts No. FS-CFS-S series braided stainless steel faucet supply.
 - h. Drain: See faucet.
 - i. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, tubular brass waste to wall; and wall escutcheon.
 - j. Protective Shielding Guard(s): PC-1

2.7 KITCHEN SINKS

- A. Kitchen Sinks, SK-3:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Just No. DBL-1823-A-GR or a comparable product by one of the following:
 - a. Kohler Co.
 - b. Moen, Inc.
 - 2. Description: Two-bowl, residential, counter-mounting, stainless-steel kitchen sink.
 - a. Overall Dimensions: 18x23
 - b. Metal Thickness: 18 gauge
 - c. Sink Faucet: Just No. J-906
 - d. Supplies: Watts No. FS-CFS-S series braided stainless steel faucet supply.
 - e. Drain Piping: Just No. J-53-S, NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch-thick tubular brass waste to wall; continuous waste; and wall escutcheon(s).
- B. Bar Sinks, SK-2:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Just No. SL-ADA-1815-A-GR-T or a comparable product by one of the following:

- a. Kohler Co.
 - b. Moen, Inc.
2. Description: Single-bowl, residential, counter-mounting, stainless-steel bar sink.
 - a. Overall Dimensions: 18x15
 - b. Bowl Dimensions: 12x12
 - c. Sink Faucet: Just No. JGN-740-W4, deck mounted faucet with 4-inch wrist blade handles.
 - d. Supplies: Watts No. FS-CFS-S series braided stainless steel faucet supply.
 - e. Drain: Just No. J-15-FS, 1-1/2-inch chrome plated grid drain.
 - f. Drain Piping: Just No. JT-150, NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch-thick tubular brass waste to wall; and wall escutcheon.
 - g. Protective Shielding Guard(s): PC-1

C. Bar Sinks, SK-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Just No. CRDF-ADA-1521-A-GR or a comparable product by one of the following:
 - a. Kohler Co.
 - b. Moen, Inc.
2. Description: Single-bowl, residential, counter-mounting, stainless-steel bar sink.
 - a. Overall Dimensions: 15x21
 - b. Bowl Dimensions: 12x12
 - c. Sink Faucet: Just No. JSVR-5 with No. JSB-10-FLX-VR, bubbler.
 - d. Supplies:
 - e. Drain: Just No. J-ADA-35-SSF-VR, 1-1/2-inch grid drain and tailpiece.
 - f. Drain Piping: Just No. JT-150, NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch-thick tubular brass waste to wall; and wall escutcheon.
 - g. Protective Shielding Guard(s): PC-1

2.8 SERVICE BASINS

A. Service Basins, MSK-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn No. Z1996-24 or a comparable product by one of the following:
 - a. Crane Plumbing, L.L.C./Fiat Products.
 - b. Florestone Products Co., Inc.
2. Description: Flush-to-wall, floor-mounting, cast polymer fixture with rim guard.
 - a. Shape: Square.
 - b. Size: 24 by 24 inches.
 - c. Height: 12 inches.
 - d. Wall Guard: On two sides.

- e. Faucet: Zurn No. SF, chrome plated faucet with vacuum breaker, 8 inch on center.
- f. Drain: Zurn No. SD, grid strainer with NPS 2 outlet.
- g. Mop Hanger: Zurn No. MH, stainless steel 24 inch by 3 inch wide.
- h. Hose & Hose Bracket: Zurn No. HH, heavy-duty 5/8 inch, by 30 inch long cloth reinforced flexible rubber hose with 3/4 inch brass coupling at one end. Bracket shall be 5 feet long x 3 inch wide, 20 gage type 304 stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

- J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- L. Install toilet seats on water closets.
- M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- O. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- Q. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- R. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Install fresh batteries in sensor-operated mechanisms –BaseE Bid.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15410END OF SECTION 15410

SECTION 15412 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following emergency plumbing fixtures:
 - 1. Combination units.
 - 2. Water-tempering equipment.
- B. Related Sections include the following:
 - 1. Division 15 Section "Plumbing Specialties" for backflow preventers and floor drains.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm (85 degrees).
- E. T.A.S.: Texas Department of Licensing & Regulations "Texas Accessible Standards".
- F. AHJ: Authority Having Jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- B. Regulatory Requirements: Comply with requirements in Texas Department of Licensing & Regulations, "Texas Accessible Standards" for plumbing fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 COMBINATION UNITS

A. Combination Units, ES-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Guardian No. GBF2150 or a comparable product by one of the following:
 - a. Haws Corporation.
 - b. Speakman Company.
2. Description: Plumbed, accessible, recessed, with emergency shower and eye/face wash equipment.
 - a. Piping: Copper pipe supply.
 - 1) Unit Supply: NPS 1 minimum from top.
 - 2) Unit Drain: NPS 2 outlet at drain pan.
 - 3) Shower Supply: NPS 1 with flow regulator and stay-open control valve.
 - 4) Eye/Face Wash Supply: NPS 1/2 with flow regulator and stay-open control valve.
 - b. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
 - 1) Control-Valve Actuator: Panic bar.
 - 2) Shower Head: 8-inch minimum diameter, chrome-plated brass.
 - c. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
 - 1) Control-Valve Actuator: Panic bar.
 - 2) Receptor: 18 gage stainless-steel combination cover & drain pan.
3. Accessories:

- 1) Modesty Curtain: Guardian No. AP250-065, one for each unit.
- 2) Signage: Guardian No. AP250-008G, one for each unit.

B. Counter Units, EF-1

1. Basis-of-Design Products: Subject to compliance with requirements, provide Guardian No. G1774 or a comparable product by one of the following:
 - a. Haws Corporation.
 - b. Speakman Company.
2. Description: Plumbed, counter mounted eye/face wash equipment.
 - a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 chrome-plated brass with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Swing activated.
 - d. Receptor: Lab sink bowl.
 - e. Mounting: verify with Architectural drawings for left or right side installation.

2.2 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment, MV-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Lawler 911 Unit No. 84708 or a comparable product by one of the following:
 - a. Bradley Corporation.
 - b. Powers, a Watts Industries Co.
2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve. No bi-metal mixing valves.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water to emergency plumbing fixtures, and maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow.

2.3 SOURCE QUALITY CONTROL

- A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted by AHJ. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 15 Section "Valves."
 - 1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 15 Section "Meters and Gages."
- G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to acid waste drainage system.
- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- I. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 15 Section "Mechanical Identification."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

- C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to acid waste drainage and vent piping.

3.4 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.5 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION 15412

SECTION 15415 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following water coolers and related components:
 - 1. Pressure water coolers.
 - 2. Fixture supports.

1.3 DEFINITIONS

- A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
- C. Fitting: Device that controls flow of water into or out of fixture.
- D. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
- E. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
- F. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in Texas department Licensing & Regulation "Texas accessible Standards" for plumbing fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- E. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filter Cartridges: Equal to 50 percent of amount installed for each type and size indicated.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Water Coolers, EDF-1:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Halsey Taylor No. HAC8FSBL-WQF-Q-ADA or a comparable product by one of the following:
 - a. Halsey Taylor.
 - b. Haws Corporation.
 - 2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for child-mounting height.
 - a. Cabinet: Bi-level with two attached cabinets and with bi-level skirt kit, all stainless steel.
 - b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 - c. Control: Push bar.
 - d. Supply: NPS 1/2.

- e. Filter: Factory equipped with Halsey Taylor No. Sentry HWF-172 water filter complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
- f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
- g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
 - 2) Electrical Characteristics: 1/6 hp; 120-V ac; single phase; 60 Hz.
- h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Halsey Taylor No. MLP200 or by one of the following:
 - 1. MIFAB Manufacturing, Inc.
 - 2. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
 - 1. Type II: Bi-level, hanger-type carrier with three vertical uprights.
 - 2. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by T.A.S. or authorities having jurisdiction.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping.
- D. Install chrome plated trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 15415

**SECTION 15422
CHEMICAL-WASTE SYSTEMS**

PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall piping.
 - 2. Piping specialties.
 - 3. Neutralization tanks.

1.3 DEFINITIONS

- A. PP: Polypropylene
- B. PVDF: Polyvinylidene Flouride

1.4 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: 10 feet head of water.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Piping and accessories shall be of the same manufacture, do mix acid waste piping and fittings. Incomplete submittals will be rejected.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks, to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
- B. Do not store plastic pipe or fittings in direct sunlight.
- C. Protect pipe, fittings, and seals from dirt and damage.

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1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Neutralization-Tank Limestone: Equal to 200 percent of amount required for each tank sump initial charge. Furnish limestone in 50-lb bags.

PART 2 - PRODUCTS

2.1 SINGLE-WALL PIPE AND FITTINGS

- A. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with mechanical-joint ends.
 - 1. Basis-of –Design Product:: Subject to compliance with requirements, provide products by Zurn Plumbing Products Group; Chemical Drainage Systems or one of the following:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.
- B. PVDF Drainage Pipe and Fittings: ASTM F 1673, Schedule 40, pipe and drainage-pattern fittings. Include fittings with fusion-joint ends.
 - 1. Basis-of –Design Product:: Subject to compliance with requirements, provide products by Zurn Plumbing Products Group; Chemical Drainage Systems or one of the following:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.

2.2 JOINING MATERIALS

- A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
- B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

2.3 PIPING SPECIALTIES

- A. Corrosion-Resistant Traps: Plumbing contractor shall provide and install acid waste tailpiece and p-trap if not supplied by Science equipment supplier.

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CHEMICAL-WASTE SYSTEMS

1. Basis-of-Design: Subject to compliance with requirements, provide products by Zurn Plumbing Products Group; Chemical Drainage Systems No. Z9A-TP and No.Z9A-PTRAP or one of the following:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.
 2. Description:
 - a. Type: P-trap or drum trap.
 - b. Size: NPS 1-1/2 or NPS 2, as required to match connected piping.
 - c. PP: ASTM D 4101, with mechanical-joint pipe connections.
- B. PP Floor Drains AFD-1: Not to be used in return air plenum areas.
1. Basis-of Design: Subject to compliance with requirements, Zurn Plumbing Products Group; Chemical Drainage system No. Z9A-FD2-R6-P or a comparable product by one of the following:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.
 2. Body: With 7- to 9-inch top diameter, with flashing flange and weep holes; and with flashing clamp and trap-primer connection.
 3. Outlet: Bottom, to match connecting pipe as indicated.
 4. Accessories: NPS 1/2 trap primer connection
 5. Note: floor drain located in return air plenums shall use Zurn Z9A-PDF1.
- C. PP Wall cleanouts AWCO:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Plumbing Products Chemical Drainage system No. Z9A-CO4 or a comparable product by one of the following:
 - a. Sloane, George Fisher Inc.
 - b. Watts Industries Inc.
- D. Floor Sinks AFS-1:
1. Basis-of-Design Product: Subject to compliance with requirements, provide MIFAB No. FS1520 or a comparable product by one of the following:
 - a. Watts Drainage Products.
 - b. Zurn Plumbing Products Group.
 2. Body: 14 inch square cast iron floor sink with white acid resistant enamel coated interior, loose set acid resistance enamel coated cast iron 3/4 grate.
 3. Outlet: Bottom, to match connecting pipe as indicated on drawings.
 4. Accessories: NPS 1/2 trap primer connection.

**SECTION 15422
CHEMICAL-WASTE SYSTEMS**

2.4 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.
2. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
 - a. Material: HDPE.
 - b. Tank Capacity: As noted on plans.
 - c. Traffic Cover: Heavy-duty pedestrian or light-duty vehicular, steel plate over plastic, bolted.
 - d. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch diameter.

2.5 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.6 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.
- C. One-Piece, Floor-Plate Escutcheons: Cast iron.
- D. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

**SECTION 15422
CHEMICAL-WASTE SYSTEMS**

3.2 PIPING INSTALLATION

A. Chemical-Waste Sewerage Outside the Building:

1. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
3. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
4. Install drainage piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
5. Install drainage piping with 36-inch minimum cover.
6. Install PVDF drainage piping according to ASTM D 2321 and ASTM F 1668.
7. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

B. Chemical-Waste Piping Inside the Building:

1. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.

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8. Install fittings for changes in direction and branch connections.
9. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - a. New Piping:
 - 1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2) Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 4) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
 - 5) Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw.
 - 6) Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - 7) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
10. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - a. Cut sleeves to length for mounting flush with both surfaces.
 - 1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - c. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
11. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - a. Install steel pipe for sleeves smaller than 6 inches in diameter.
12. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - a. Sleeve-Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

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13. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
14. Verify final equipment locations for roughing-in.

3.3 PIPING SPECIALTY INSTALLATION

- A. Embed floor drains in 4-inch minimum depth of concrete around bottom and sides. Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for concrete.
- B. Fasten grates to drains if indicated.
- C. Set floor drains with tops flush with pavement surface.
- D. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.
 1. Set cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade. Set cleanout plugs in concrete pavement with tops flush with pavement surface. Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete requirements.
- E. Install backwater valves in horizontal position. Include riser to cleanout at grade.

3.4 JOINT CONSTRUCTION

- A. Chemical-Waste Sewerage Outside the Building:
 1. Plastic-Piping, Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
- B. Chemical-Waste Piping Inside the Building:
 1. Plastic-Piping Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe sizes in this article refer to aboveground, single-wall piping.
- B. Basis-of-Design product: Subject to compliance with requirements provide B-Line or a comparable product by one of the following:
 - a. Portable Pipe Hanger
 - b. Erico

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- C. Install the following:
1. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- E. Support vertical piping and tubing at base and at each floor.
- F. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch.
- G. Install B-Line No. B317ONFC vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2: 33 inches with 3/8-inch rod.
 2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- H. Install supports for vertical PP piping every 72 inches.
- I. Install B-Line No. B317ONFC vinyl-coated hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameters:
1. All Sizes: Install continuous support for piping with liquid waste at temperatures above 140 deg F.
 2. NPS 1/2 and Smaller: 30 inches with 3/8-inch rod.
 3. NPS 3/4 to NPS 1-1/2: 36 inches with 3/8-inch rod.
 4. NPS 2: 36 inches with 3/8-inch rod.
 5. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
 6. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- J. Install supports for vertical PVDF piping NPS 1-1/2 every 48 inches and NPS 2 and larger every 72 inches.

3.6 NEUTRALIZATION TANK INSTALLATION

- A. Install exterior neutralization tanks, complete with appurtenances indicated.
1. Set tops of tank covers flush with finished surface where covers occur in pavements. Set covers 3 inches above finished surface elsewhere unless otherwise indicated.
 2. Include initial fill of limestone for neutralization tanks.

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CHEMICAL-WASTE SYSTEMS**

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Use commercially manufactured wye fittings for acid waste piping branch connections.
- C. Install piping adjacent to equipment to allow service and maintenance.

3.8 FIELD QUALITY CONTROL

- A. Inspect interior of acid waste piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.
 - 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Hydrostatic Tests for Drainage Piping:
 - 1) Close openings in system and fill with water.
 - 2) Purge air and refill with water.
 - 3) Disconnect water supply.
 - 4) Test and inspect joints for leaks.
 - 2. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Submit separate reports for each test.
- B. Replace leaking acid waste piping using new materials, and repeat testing until leakage is within allowances specified.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect assembled neutralization systems and their installation, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- E. Prepare test and inspection reports.

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3.9 STARTUP SERVICE

- A. startup service for neutralization systems.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Neutralization Systems:
 - a. Verify that neutralization system is installed and connected according to the Contract Documents.
 - b. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.
 - c. Install neutralizing solutions and limestone.
 - d. Energize circuits.
 - e. Start and run systems through complete sequence of operations.
 - f. Adjust operating controls.
 - g. .

3.10 ADJUSTING

- A. Adjust neutralization-system set points.

3.11 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Clean piping by flushing with potable water.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain neutralization systems.

3.13 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
- B. Aboveground Chemical-Waste Piping: Use the following piping materials for each size range:
 - 1. NPS 1-1/2 to NPS 6: PP drainage piping and mechanical joints in non return air plenums.
 - 2. NPS 1-1/2 to NPS 6: PVDF drainage piping and mechanical joints in areas with a return air plenum.

**SECTION 15422
CHEMICAL-WASTE SYSTEMS**

- C. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use the following piping materials for each size range:
 - 1. NPS 1-1/2 to NPS 6: PP drainage piping and electrofusion joints.

END OF SECTION 15223

**SECTION 15485
ELECTRIC WATER HEATERS**

PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. This Section includes the following electric water heaters:
 - 1. Household, small-capacity electric water heaters.
 - 2. Water heater accessories.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. LEED Submittal:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2004, Section 7 - "Service Water Heating."
- C. Shop Drawings: Diagram power, signal, and control wiring.
- D. Product Certificates: For each type of electric water heater, signed by product manufacturer.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

**SECTION 15485
ELECTRIC WATER HEATERS**

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- E. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Household Electric Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Three years.

PART 2 - PRODUCTS

2.1 HOUSEHOLD ELECTRIC WATER HEATERS

- A. Household, Standard, Storage Electric Water Heaters: Comply with UL 174.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide A.O. Smith DSE or a comparable product by one of the following:
 - a. Rheem Water Heater Div.; Rheem Manufacturing Company.
 - b. State Water Heater.

**SECTION 15485
ELECTRIC WATER HEATERS**

2. Storage-Tank Construction: Steel.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004.
 - e. Jacket: Steel with enameled finish.
 - 1) Standard: Cylindrical shape.
 - f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Two; electric, screw-in immersion type with 3.0 kW or less total, and wired for non-simultaneous operation, unless otherwise indicated.
 - h. Temperature Control: Adjustable thermostat for each element.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

4. Capacity and Characteristics:
 - a. Capacity: As indicated on schedule on drawings
 - b. Recovery: 12 gph at 100 deg F temperature rise.
 - c. Jacket: Cylindrical shape.
 - d. Heating Elements:
 - 1) Number: Single.
 - 2) Power Demand Each: 3.0 kilowatt.
 - e. Temperature Setting: 130 deg F.
 - f. Electrical Characteristics:
 - 1) Total Power Demand: 3.0 kilowatt.
 - 2) Volts: 208.
 - 3) Phases: Single.
 - 4) Hertz: 60.
 - 5) Full-Load Amperes: 14.4

**SECTION 15485
ELECTRIC WATER HEATERS**

2.2 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Combination suspended water heater support and drain pan: Provide Hold-Rite No. 40-SWHP.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004.
- D. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

2.3 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains.
- C. Install thermometer on outlet piping of water heaters. Refer to Division 15 Section "Meters and Gages" for thermometers.
- D. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- E. Fill water heaters with water.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

**SECTION 15485
ELECTRIC WATER HEATERS**

- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain electric water heaters. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 15485END OF SECTION 15485

**SECTION 15486
FUEL-FIRED WATER HEATERS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following fuel-fired water heaters:
 - 1. Commercial, high-efficiency, gas water heaters.
 - 2. Compression tanks.
 - 3. Water heater accessories.

1.3 DEFINITIONS

- A. LP Gas: Liquefied-petroleum fuel gas.

1.4 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. LEED Submittal:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2004, Section 7 - "Service Water Heating."
- C. Shop Drawings: Diagram power, signal, and control wiring.
- D. Product Certificates: For each type of commercial water heater, signed by product manufacturer.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For water heaters to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

**SECTION 15486
FUEL-FIRED WATER HEATERS**

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Commercial, Gas Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Five years.
 - b. Compression Tanks: One year(s).

**SECTION 15486
FUEL-FIRED WATER HEATERS**

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS WATER HEATERS

- A. Commercial, Direct sealed-combustion & direct venting High-Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
1. Basis-of-Design Product: Subject to compliance with requirements, provide A.O. SMITH No. BTH-199 or a comparable product by one of the following:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 2. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions. Following features and attributes may be modified or omitted if water heater otherwise complies with requirements for performance.
 3. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 4. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
 5. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for high-efficiency water heaters and for natural-gas fuel.
 6. Temperature Control: Adjustable thermostat.
 7. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

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FUEL-FIRED WATER HEATERS**

8. Capacity and Characteristics:
 - a. Capacity: 100 gal..
 - b. Recovery: 230 gph at 100 deg F temperature rise.
 - c. Temperature Setting: 160 deg F.
 - d. Fuel Gas Demand: 199 cfh.
 - e. Gas Pressure Required at Burner: 7 inches water column.
 - f. Electrical Characteristics:
 - 1) Volts: 120.
 - 2) Phase: Single.
 - 3) Hertz: 60.
 - 4) Full-Load Amperes: 10 amps
 - g. Minimum Vent Diameter: 3 inches.
 - h. Blower: 120 volt, 2.2 amps.
 - i. Igniter: 120 volt, 4.0 amps

2.2 COMPRESSION TANKS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Wessels Co.
 - b. AMTROL Inc.
2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.

2.3 WATER HEATER ACCESSORIES

- A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
- B. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.

**SECTION 15486
FUEL-FIRED WATER HEATERS**

- C. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.
- D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases.
 - 1. Concrete base construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install gas water heaters according to NFPA 54.
- D. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
- E. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
- F. Install combination temperature and pressure relief valves in top portion of storage tanks if not factory installed. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 15 Section "Plumbing Specialties" for hose-end drain valves.

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FUEL-FIRED WATER HEATERS

- H. Install thermometer on outlet piping of water heaters. Refer to Division 15 Section "Meters and Gages" for thermometers.
- I. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 15 Section "Valves" for general-duty valves and to Division 15 Section "Meters and Gages" for thermometers.
- J. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- K. Fill water heaters with water.
- L. Charge compression tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters.

SECTION 15486
FUEL-FIRED WATER HEATERS

END OF SECTION 15486END OF SECTION 15486

SECTION 15492
FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
1. Pipes, tubes, and fittings.
 2. Piping specialties.
 3. Piping and tubing joining materials.
 4. Valves.
 5. Pressure regulators.
 6. Grout.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Regulators:
1. Line Regulator: Regulator installed downstream of Service Regulator.
 2. Service Regulator: Regulator installed at gas meter, typically installed by gas supplier. Contractor shall coordinate with gas supplier for gas meter & service regulator installation requirements and shall include in his bid price to include gas meter & service regulator if not installed by gas supplier.
 3. Appliance regulator: Regulator installed at appliance by appliance manufacture.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 2. Service Regulators: 65 psig minimum unless otherwise indicated.
 3. Minimum Operating Pressure of Service Meter: 5 psig.

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FACILITY NATURAL-GAS PIPING

- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
1. Piping specialties.
 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 3. Pressure regulators. Indicate pressure ratings and capacities.
 4. Dielectric fittings.
 5. Escutcheons.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, and piping layout.
1. Shop Drawing Scale: 1/8 inch per foot.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For motorized gas valves pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

**SECTION 15492
FACILITY NATURAL-GAS PIPING**

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 4. Corrugated stainless-steel tubing with polymer coating.
 5. Operating-Pressure Rating: 0.5 psig.
 6. End Fittings: Zinc-coated steel.
 7. Threaded Ends: Comply with ASME B1.20.1.
 8. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
1. Copper-alloy convenience outlet and matching plug connector.
 2. Nitrile seals.

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FACILITY NATURAL-GAS PIPING

3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts FBV-4 series, product or a comparable product by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.

**SECTION 15492
FACILITY NATURAL-GAS PIPING**

b. Hammond Valves Inc.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 **MOTORIZED GAS VALVES**

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Magnatrol Valve Corporation.
 - c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.6 **PRESSURE REGULATORS**

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

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- a. Actaris.
 - b. Eclipse Combustion, Inc.
 - c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 5 psig.

2.7 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - c. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - c. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.

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5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.8 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Inspect natural-gas piping according to NFPA 54 and local Plumbing Code to determine that natural-gas utilization devices are turned off in piping section affected.
- B. Comply with NFPA 54 and local Plumbing Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and local Plumbing Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

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- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.
- F. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
- G. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the Uniform Plumbing Code and local amendments for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.

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- J. Install fittings for changes in direction and branch connections.
- K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Piping in Equipment Rooms: One-piece, cast-brass type.
 - f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."
- M. Verify final equipment locations for roughing-in.
- N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- P. Extend relief vent connections for line regulators, and overpressure protection devices installed indoors to outdoors and terminate with weatherproof vent cap.
- Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

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- a. Exception: Tubing passing through partitions or walls does not require striker barriers.
3. Prohibited Locations:
- a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- T. Connect branch piping from top or side of horizontal piping.
- U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- V. Do not use natural-gas piping as grounding electrode.
- W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- X. Install pressure gage upstream and downstream from each line regulator.
- 3.5 VALVE INSTALLATION
- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
 - B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
 - C. Install anode for metallic valves in underground PE piping.
- 3.6 PIPING JOINT CONSTRUCTION
- A. Ream ends of pipes and tubes and remove burrs.
 - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.

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5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers and Supports."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

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1. Test, inspect, and purge natural gas according to NFPA 54 and local Plumbing Code and authorities having jurisdiction.
 - C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.10 OUTDOOR PIPING SCHEDULE
- A. Underground natural-gas piping shall be the following:
 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - B. Aboveground natural-gas piping shall be the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
 - C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- 3.11 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG
- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
 - B. Aboveground, distribution NPS 2 and smaller piping shall be the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
 - C. Aboveground, distribution NPS 2-1/2 and larger piping shall be the following:
 1. Steel pipe with wrought-steel fittings and welded joints.
- 3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG
- A. Aboveground, branch piping NPS 2 and smaller shall be the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
 - B. Aboveground, distribution piping NPS 2-1/2 and larger shall be the following:
 1. Steel pipe with steel welding fittings and welded joints.

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3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- E. Valves in branch piping for single appliance shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 15195

**SECTION 15535
REFRIGERANT PIPING**

PART 1. GENERAL**1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1 - General Requirements and referenced documents.
- B. Comply with Division 15 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 SYSTEM DESCRIPTION:

- A. Furnish and install refrigerant piping between condensing unit and evaporator coil of sizes, which are recommended by the manufacturer. Make final connections to all equipment.
- B. Provide flexible refrigerant connections at all equipment.
- C. Piping shall be field fabricated from hard drawn copper piping with wrought copper fittings and brazed joints as specified herein. Contractor may use factory pre-charged, pre-insulated copper refrigerant lines with quick-connect couplings in lieu of field fabricated piping above grade only.

PART 2. PRODUCTS**2.1 MATERIALS:**

- A. Field Fabricated Piping Above Grade: Type L hard drawn copper tubing with brazed joints.
- B. Field Fabricated Piping Below Grade: Type K soft copper tubing with brazed routed in PVC sleeve. No joints will be allowed underground.
- C. Pre-charged Piping (Above Grade Only): Type L annealed copper tubing with quick-connect fittings to match connections to equipment.
- D. Field Fabricated Fittings: Wrought copper with brazed joints.
- E. Solder: Silver solder having a minimum melting point of 1050 Deg F
- F. Solenoid Valves: Sporlan solenoid valves with ODF solder connections, type and size to match the service intended.
- G. Liquid and Moisture Indicators: Sporlan "See-All" moisture and liquid indicator with ODF solder connections.

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Field fabricated refrigerant lines shall be installed by workmen skilled in the installation and testing of refrigerant piping and refrigerant equipment.
- B. All work shall conform to standard engineering practice as recognized by ARI and the

**SECTION 15535
REFRIGERANT PIPING**

American Society of Heating, Refrigerating and Air Conditioning Engineers, and all piping, installation and testing shall conform to the applicable requirements of ANSI B9.2.

- C. All refrigerant lines shall be properly pitched and shall have oil traps properly sized, located and installed, complete with properly sized double suction risers, to ensure that oil in any part of the system will be able to return to the compressor under minimum system operating conditions.
- D. Each refrigerant circuit shall have a minimum of one liquid and moisture indicator, one liquid line dryer and one set of charging valves.
- E. Install pre-charged piping with short radius bends as required for a neat and workmanlike installation. When making bends, strip insulation from area of bend and use only a lever type hand bender, which is of the proper size for the tubing being bent. Replace all piping which collapses or buckles during installation. Replace insulation and secure to piping after piping is in place.
- F. All joints on field fabricated piping shall be brazed using 1050 Deg. F silver solder or "Silfos." Circulate dry nitrogen through all tubes and fittings being soldered to eliminate formation of copper oxide during brazing operation. Valves and accessories shall be protected against excessive temperature during brazing.
- G. All field fabricated pipe shall be cut smooth and square with an approved type of pipe cutter. Pipe shall be reamed, cuttings carefully removed and piping thoroughly cleaned of all dirt and oil before brazing.
- H. All refrigerant lines installed below concrete shall be installed in a Schedule 40 PVC pipe sleeve to protect pipe and insulation.
- I. All piping shall be thoroughly tested for leaks and proved tight before charging. Evacuate system to not less than 500 microns with oil submerged vacuum pump and special vacuum hoses. Hold for two hours. Charge shall be calculated and a volume charging cylinder or electronic scale shall be utilized. Affix a tag to each system showing type of refrigerant and total pounds in the system.
- J. Cleaning: Clean all fittings before installation. Pipes shall be capped ACR refrigerant grade pipe or pre-charged refrigerant grade pipe.

END OF SECTION

**SECTION 15670
AIR COOLED CONDENSING UNITS (UP TO 5 TONS)**

PART 1. GENERAL**1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1 - General Requirements and referenced documents.
- B. Comply with all other Division 15 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 air cooled condensing 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.
- B. Shop Drawings: Submit in accordance with Section 15010.
- C. Refrigerant Piping Diagrams: Contractor is responsible for assembling and submitting complete manufacturer approved refrigerant piping diagrams indicating sizing, routing, valves and all devices/appurtenances necessary to complete the system to the satisfaction of the owner, engineer, and equipment manufacturer. These submittals must be approved by the manufacturer prior to commencing the submittal process.

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 15010.

PART 2. PRODUCTS**2.1 EQUIPMENT:**

- A. Provide air cooled condensing units in location and manner shown on Drawings. Unit shall be properly assembled and tested at factory. Unit shall be designed for use with Refrigerant 22.
- B. Performance: Capacities shall be as shown on unit schedule.
- C. Nominal unit electrical characteristics shall be as indicated on drawings. Unit shall be capable of satisfactory operation within voltage limits of 10% in either direction.
- D. Acceptable Manufacturers:

**SECTION 15670
AIR COOLED CONDENSING UNITS (UP TO 5 TONS)**

1. Trane
2. Carrier
3. York
4. Lennox

2.2 AIR COOLED CONDENSING UNITS:

- A. Coil: Coil shall be of nonferrous construction. Coil shall have aluminum plate fins, mechanically bonded to seamless copper tubes.
- B. Fans and Motors: Provide unit with direct-driven, propeller-type fans arranged for vertical discharge. Fan motors shall have Class B motor insulation, inherent protection, and shall be of the permanently lubricated type, resiliently mounted. Each fan shall have a safety guard.
- C. Compressor: Each compressor shall be of a replaceable hermetic design with externally mounted brass service valves and charging connections, resilient rubber mounts and compressor motor overload protection. Compressor motors shall have across-the-line start and shall be approved for continuous operation down to 0 degrees F. Provide hot gas bypass on lead compressor if coupled with outside air pretreatment unit or unit utilizing variable volume air design. See outside air, air handling unit/coil, and /or control specification.
- D. Controls: Factory wired and located in a separate enclosure. Safety devices shall consist of high and low pressure switches, crankcase heater, suction line accumulator and pressure relief devices. Unit wiring shall incorporate a positive acting timer to prevent short cycling of compressor if power is interrupted. Timer shall prevent compressor from restarting for approximately 5 minutes after shutoff.
- E. Casing: Casing shall make unit fully weatherproof for outdoor installation. Casing shall be of galvanized steel, zinc phosphatized and finished with baked enamel.
- F. Openings shall be provided for power and refrigerant connections. Panel shall be removable to provide access for servicing. Units shall have a hinged access door on control panel.
- G. Connections: Only one liquid line, one suction line and one power supply connection shall be required for each unit.
- H. Provide unit with hail guard, low ambient cut-off switch, filter drain, and accessories indicated on equipment schedules.
- I. Provide heresite coating on condenser coils at sites within 50 miles of coastline.

2.3 IDENTIFICATION:

- A. Equipment Identification - Nameplate: All nameplates shall be laminated phenolic material, black exterior with white core. Nameplate edges shall be neatly beveled and engraving shall show white letters on a black background. Attach nameplates by means of self-tapping metal screws. Use adhesive will be not be permitted.

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AIR COOLED CONDENSING UNITS (UP TO 5 TONS)**

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Install air cooled condensing units in accordance with the Drawings, approved shop drawings and manufacturer's instructions and recommendations.

END OF SECTION

**SECTION 15775
SPLIT SYSTEM AIR COOLED HEAT PUMPS**

PART 1. GENERAL**1.1 RELATED REQUIREMENTS:**

- A. General Requirements: Comply with the requirements of Section 15010 - GENERAL PROVISIONS.
- B. Comply with Division 15 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 DESCRIPTION:

- A. This section covers furnishing and installing split system heat pumps of the style, design and capacity as indicated on drawings.

1.3 SUBMITTALS:

- A. Submit manufacturer's literature, engineering data and shop drawings in accordance with the requirements of Section 15010 - GENERAL PROVISIONS.
- B. Submittal data and shop drawings shall include but not be limited to:
 - 1. Arrangement of units
 - 2. Wiring Diagrams
 - 3. Dimensions of units
 - 4. Electrical characteristics: voltage, phase, hertz, and amps
 - 5. Location and size of piping corrections
 - 6. Refrigeration capacity
 - 7. Location and size of supports, including details of connections to units and to building.
 - 8. Weight of units
- C. Installation and Operating Instructions: Submit installation and instruction manuals, complete with a description of all installation, operation and maintenance instructions. All factory inspection and operational test reports shall be included with the manuals.
- D. Recommended Spare Parts Lists: Submit list of recommended spare parts for all items covered by this specification. Include description of parts, part numbers, price of each part and a minimum of three (3) locations where parts can be obtained.

1.4 PRODUCT HANDLING, DELIVERY AND STORAGE:

- A. Delivery, handling and storage of material covered by this specification shall conform to the requirements of Section 15010 - GENERAL PROVISIONS.
- B. Delivery: Receive, unload and deliver split system heat pumps to installation site or to storage, and then installation site. Inspect units when they are received and immediately

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SPLIT SYSTEM AIR COOLED HEAT PUMPS**

report any damage or shortage.

- C. Storage: Store Units, which cannot be installed immediately after delivery in a safe, dry location.
- D. Handling:
 - 1. Remove protective caps or coverings at time of installation and check for cleanliness.
 - 2. Remove obstructions as required.
 - 3. Follow manufacturer's installation instructions.

1.5 GUARANTEE:

- A. Products and workmanship specified in this section of the specification shall comply with the guarantee requirements of Section 15010 - GENERAL PROVISIONS.

PART 2. PRODUCTS

2.1 EQUIPMENT:

- A. Provide split system heat pumps in location and manner shown on Drawings. Unit shall be properly assembled and tested at factory. Designed for use with Refrigerant 22.
- B. Performance: Capacities shall be as shown on unit schedule.
- C. Nominal unit electrical characteristics shall be as indicated on drawings. Unit shall be capable of satisfactory operation within voltage limits of 10% in either direction.
- D. Acceptable Manufacturers:
 - 1. Trane
 - 2. Carrier
 - 3. York
 - 4. Lennox

2.2 HEAT PUMPS:

- A. Coil shall be of nonferrous construction. Coil shall have aluminum plate fins, mechanically bonded to seamless copper tubes.
- B. Fans and Motors: Provide unit with direct-driven, propeller-type fans arranged for vertical discharge. Fan motors shall have Class B motor insulation, inherent protection, and shall be of the permanently lubricated type, resiliently mounted. Each fan shall have a safety guard.
- C. Compressor: Provide unit with number of compressors as per scheduled on Drawings. Each compressor shall be of serviceable heat pump duty hermetic design with external isolators automatically reversible oil pump, and internal and external motor protection. Compressor motors shall have across-the-line start and shall be approved for continuous

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SPLIT SYSTEM AIR COOLED HEAT PUMPS**

operation down to -30 degrees F in the heating mode and down to 55 degrees F in the cooling mode.

- D. Controls: Factory wire and locate in a separate enclosure. Safety devices shall consist of high and low pressure switches crankcase heater, suction line accumulator and pressure relief devices. Unit wiring shall incorporate a positive acting timer to prevent short cycling of compressor if power is interrupted. Timer shall prevent compressor from restarting for approximately 5 minutes after shutoff. An automatic defrost control shall also be included to accomplish defrosting every 90 minutes for a period of not more than 10 minutes.
- E. Casing shall make unit fully weatherproof for outdoor installation. Casing shall be of galvanized steel, zinc phosphatized and finished with baked enamel.
- F. Openings shall be provided for power and refrigerant connections. Panel shall be removable to provide access for servicing. Units shall have a hinged access door on control panel.
- G. Connections: Only one liquid line, one suction line and one power supply connection shall be required for each unit.
- I. Provide hail guard and accessories indicated on equipment schedules.
- I. Provide heresite coating on condenser coils at sites within 50 miles of coastline.

2.3 SMOKE DETECTORS:

- A. Smoke detectors shall be provided for all units and /or smoke dampers as required by the governing authorities and as specified specifically in Division 16 Fire Alarm Section.
- B. Wiring of all smoke detectors shall be installed by a licensed electrician as covered in Division 16.
- C. It is the contractors responsibility to properly coordinate the smoke detectors and the subsequent wiring /control, and alarm system in order to provide the owner with a complete operational system meeting the requirements as set forth by the governing authority or authorities having jurisdiction.

2.4 IDENTIFICATION:

- A. Equipment Identification - Nameplate: All nameplates shall be laminated phenolic material, black exterior with white core. Nameplate edges shall be neatly beveled and engraving shall show white letters on a black background. Attach nameplates by means of self-tapping metal screws. Use adhesives will not be permitted.

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Install split system heat pumps in accordance with the Drawings, approved shop drawings and manufacturer's instructions and recommendations.

**SECTION 15775
SPLIT SYSTEM AIR COOLED HEAT PUMPS**

END OF SECTION

**SECTION 15789
PACKAGED MULTIZONE UNIT**

PART 1 PRODUCTS – ENERGY RECOVERY UNIT

1.1 MANUFACTURERS

- A. Provide energy recovery unit as manufactured by Innovent Air Handling Equipment or pre-approved equal
- B. Pre-Approved equals are subject to compliance with all the requirements listed in this specification. Pre-Approval of a manufacturer other than the specified manufacturer does not constitute acceptance of standard construction, components, or designs of the pre-approved manufacturer.
- C. Project is based on the specified equipment. Any additional costs associated with using a manufacturer other than specified shall be borne by the installing contractor.

1.2 CONSTRUCTION

- A. General. Construct unit as specified herein. Single wall and 1" double wall casing are unacceptable. Fans and coils must be removable without dismantling the structural framing of the unit. Unit shall be suitable for outdoor installation.
- B. Base: Construct base of welded structural steel G shape and welded steel cross supports and integral lifting lugs. Bolted bases are unacceptable. Base shall be insulated and provided with a 22 ga. G90 galvanized steel bottom liner. Coat base with 2 part epoxy primer and urethane modified enamel top coat.
- C. Casing: Unit shall have non-load bearing heavy gauge 2" double-wall steel casing. If casing is load bearing exterior shall be minimum 16 ga. and interior shall be minimum 18 ga.
- D. Casing: Unit shall have non-load bearing heavy gauge 2" double-wall steel casing. If casing is load bearing exterior shall be minimum 16 ga. and interior shall be minimum 18 ga. Frame is constructed of formed galvanized members designed to support flush-mounted double-wall panels. Framing must have gasketing between support members and panels. Casing must be thermal break construction.
- E. Coatings: Exterior casing shall be galvanized G90/ coated with 2 part epoxy primer with urethane modified enamel top coat. Galvanized exterior unacceptable if unit casing or framework is welded. Interior casing shall be galvanized G90/ aluminum.
- F. Insulation: All interior walls, floor, and roof shall be double wall and insulated. Wall casings are insulated with 2 lb/ft³ urethane foam insulation having an average R-value of 6 per inch. Floors shall be insulated to achieve minimum R13. No insulation shall be exposed to the air stream.
- G. Casing insertion loss. The insertion loss, per octave band, for the casing shall not be less than the following:

Frequency:	<u>63</u>	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>	<u>8000</u>
Insertion loss, dB:	24.8	24.1	22.3	24.7	26.1	29.0	31.2	33.1
Frequency:	<u>100</u>	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>	<u>8000</u>
Insertion loss, dB:	24	16	30	32	33	34	63	60

Provide verifying test results from lab accredited by the US Dept. of Commerce and the National Institute of Standards and Technology (NIST). Insertion loss verification shall be in accordance with ISO 3746: 1975 Acoustics-survey (comparison) method.

- H. Access Doors: Provide double wall insulated doors with stainless steel piano hinges, minimum two compression latches, and minimum 24" clear opening width. Supply and exhaust air streams shall not be covered by a single door. Provide doors for access to filters, fans, heat exchangers

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and any area requiring access for routine maintenance. Access panels in lieu of access door are unacceptable. .

Door Accessories:

1. Access doors shall be provided with door tie backs.

- I. Weather hoods (for outdoor units): Provide weather hoods and bird screens over all exposed inlets and outlets. Ship hoods loose for installation in the field.
- J. Roof (for outdoor units): Provide roof with standing seam construction. Pitch roof with sufficient slope to ensure water drainage.

1.3 BLOWER/MOTOR

- A. General: Scroll fans shall have minimum 0.7 wheel diameter clearance to walls. Belt drive fans shall have pillow block bearings with minimum L-50 200,000 hour rating. Permanently sealed bearing and "star bracket" bearing supports are not acceptable.
- B. Blowers: Supply blower shall be [plenum] type with [AF] wheel. Exhaust blower shall be Class [SWSIJ] type with [FC] wheel.
- C. Plenum blowers shall be 12 blade aluminum airfoil with minimum L-50 400,000 hour rated bearings. Plenum fans with less than 12 blades are not acceptable. All wheels shall be statically and dynamically balanced on precision electronic balancers to a Balance Quality Grade G6.3 per ANSI/AMCA 204 or better.
- D. Motors: Motors shall be 3 phase ODP with NEMA frame and 1.15 service factor. Motor base shall be adjustable. Motor brake horsepower shall not exceed scheduled values. Fan brake horsepower shall not exceed 85% of motor horsepower. All motors shall comply with EPACT efficiency requirements.
- E. Drives: Drives shall be adjustable for 10hp motors and smaller, fixed for 15 hp motors and larger. All drives shall be minimum 2-groove with 2 belts and minimum 1.2 service factor. Air balancing contractor to provide final drive set as required.
- F. Isolation: Blower and motor shall be mounted on a unitary base with [2" housed seismic rated spring] isolators.
- G. Accessories:
 1. Lube Lines: Provide extended lube lines for fans/motors. Terminate lube lines [inside nearest access door].
 2. Fan Guards. Provide guards for the following: [fan belts].

1.5 DAMPERS.

- A. General: Motorized dampers shall be low leakage type with [aluminum] frame, [airfoil] [aluminum] blades, vinyl edge seals, metal jamb seals, and synthetic bearings. Gravity dampers shall have aluminum frame, aluminum blades, extruded vinyl edge seals, and synthetic bearings.
- B. The following dampers shall be provided:
 1. Outside air damper, opposed blade type, 2-position actuator.
 2. Exhaust gravity damper.

1.6 FILTERS.

- A. Return air filter: Provide 2" Purolator; 40%, MERV 8, (or equal) filter bank at the return air inlet of the heat exchanger. Mount in side access slide rack and size for 500 fpm maximum face velocity.

HEATING.

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- A. Direct fired gas furnace: Provide furnace with electronic flame safety system, spark ignition system, high limit, and air proving switch. Gas train shall be [standard]. Gas valve shall be full modulating with 25:1 turndown.

1.8 COOLING

- A. DX cooling coil: Provide ARI rated coil with 0.02" thick seamless copper tubes and 0.0075" thick aluminum fins, pressure tested and guaranteed for 250 psi working pressure. Provide [stainless steel] IAQ drain pan under the coil extending past the coil to ensure condensate retention. Coil shall be [2 circuit face interlaced]. Maximum face velocity is 500 FPM. Stub suction line through unit casing (distributor to remain inside unit).
- B. Hot Gas Reheat: A hot gas reheat coil shall be provided with performance parameters as specified in the schedule. Coil is constructed of seamless copper tube primary surface and rippled aluminum plate fin secondary surface. Core is tested with 315-psig air pressure under warm water and guaranteed for 250 psig working pressure.

Note: Hot gas reheat coil shall have a 3-way, modulating control valve. Control of the HGR coil 3-way valve shall be by Innovent.

- C. Integral condensing unit: Provide integral air cooled condensing system factory piped, wired, charged, and tested. Entire condensing section must be assembled by the unit manufacturer. Skid mounting another manufacturers condensing unit is not acceptable.
1. Provide hermetic scroll type compressors with suction and discharge service valves, reverse rotation protection, sight glass, oil level adjustment, oil filter, rotary dirt trap, non-short cycling control, and high and low pressure limits.
 2. Provide condenser coils with galvanized casing, seamless copper tubes, and aluminum fins.
 3. Condenser fans shall be direct drive with fan guards.
 4. Independent circuits shall be provided completely tested, dehydrated, and fully charged with R-410A and oil.
 5. Provide hot gas bypass on [lead] circuit(s) with HGB valve and solenoid valve.
 6. Provide a hot gas reheat coil with a three-way modulating control valve.
 7. A minimum of 4 compressors must be provided.

COOLING/HEATING

- D. DX cooling coil: Provide ARI rated coil with 0.02" thick seamless copper tubes and 0.0075" thick aluminum fins, pressure tested and guaranteed for 250 psi working pressure. Provide [stainless steel] IAQ drain pan under the coil extending past the coil to ensure condensate retention. Maximum face velocity is 500 FPM.

1.9 ELECTRICAL.

- A. Wire units according to NEC and ETL list the entire unit. ETL listing of electrical panel only is unacceptable. All major electrical components shall be UL listed. Factory wire unit for single point power connection. Enclose all power wiring in liquid tight conduit.
- B. Provide fused disconnect, fan motor starters/protectors, contactors, control transformer, control circuit fusing, service switch, and terminal block.
- C. Provide NEMA 3R electrical/control panel.
- D. Factory test wiring and controls before shipment.

1.10 CONTROLS/SEQUENCE OF OPERATION

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- A. O/A and E/A damper sequence. When disconnect switch is “off”, supply and exhaust fans de-energized and outside air and exhaust air dampers close. When disconnect switch is switched “on” the exhaust fan energizes. After the exhaust damper opens, the outside air damper opens, when O/A damper is full open the supply fan energizes.
- B. Standard defrost/economizer control sequence. Provide proportional/integral controller with defrost sensor in the exhaust air stream leaving the exchanger and economizer sensor in the outside air stream. Summer/winter changeover shall not be required. All temperature settings shall be field adjustable. Temperatures shown are factory settings.
 - 1. (Alternate) Winter Defrost Mode (exhaust air temperature leaving the heat exchanger less than 40°F): DDC will open/close the face dampers in sequence to prevent the exhaust airstream temperature from dropping below 40°F. The face dampers sequence open/closed, to melt any frost on the exhaust side of the heat exchanger.
- A. Defrost control sequence. A proportional temperature controller (with sensor mounted in the exhaust airstream leaving the heat exchanger) modulate the face/bypass damper, bypassing only the air required to prevent the exhaust leaving temperature from falling below 33°F.
- B. Recirculation. On a call for recirculation from time clock or switch the exhaust fan shall de-energize, the outside air damper shall close, and recirculation damper shall open. Time clock or switch shall be provided by [\[controls contractor\]](#).
- C. Heating Controls.
 - 1. Direct fired furnace.
- D. Cooling controls
 - 1. DX coil.
- E. Remote control panel. A NEMA 1 enclosure will be provided with NEMA 4X oil tight on/off switch and terminal block. Remote panel will include [\[fan on/off switches, NEMA 4X oiltight indicator lights for switches, dirty filter alarm, low limit alarm, electronic 7 day time clock, electromechanical 7 day time clock\]](#).
- F. Control accessories:
 - 1. Safeties: Provide [\[manual reset firestat, low limit stat, freezstat\]](#). Stat(s) shall be [\[installed and wired in the factory/provided by the contractor and mounted and wired in the field\]](#).
 - 2. Smoke detector. Provide [\[1/2\] smoke detector\(s\)](#). Detectors shall be [\[installed and wired in the factory/provided by the contractor and mounted and wired in the field\]](#). Mount smoke detector(s) in [\[supply/exhaust\] air streams](#).

1.11 DDC SYSTEM

- A. Provide stand-alone programmable digital control system.
- B. [Manufacturer must provide a stand-alone programmable digital control system with sequence as specified in section 15959. All controls shall be provided to the manufacturer for factory mounting and wiring. All control shall be provided and installed in the field by the ATC contractor.](#)

1.12 ACCESSORIES.

- A. Roof curb: A [\[14\]](#)" prefabricated insulated roof curb will be provided for the unit. The curb will be suitable for a [\[flat\]](#) roof. The curb will be shipped disassembled.
- B. Filter pressure gages: Provide magnahelic pressure gages across all filter racks. Route tubing from pressure taps at filter rack to gage mounted on exterior of unit.
- C. Dirty filter indicators: Provide differential pressure switches across all filter racks. Wire pressure switches to terminal block in main electrical panel.

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- D. Convenience Receptacles: Provide a GFCI duplex receptacle mounted near the electrical panel and wire receptacle to a terminal strip in the electrical panel. Separate 120V power must be provided to the receptacle.
- E. A supply duct silencer shall be provided integral to the unit casing. It shall be constructed of 22 ga. galvanized outer casing with internal baffles constructed of 22 ga. galvanized perforated steel with inorganic glass fiber acoustic material. Silencer shall be a minimum of 3 feet long and have the following insertion loss ratings at minimum:

	Frequency:	<u>63</u>	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>	<u>8000</u>	
	Insertion loss, dB:		5					7		17
27	35		32					20		13

- F. Lockable access doors.

END OF SECTION

SECTION 15820
OUTSIDE AIR UNIT (DX) – PACKAGED ROOFTOP ASSEMBLY

1 **GENERAL**

- 1.1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.
- 1.2 Substitution of any product other than that specified, must assure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for “equal” or “alternate” must address these factors.
- 1.3 Each air-handling unit to be configured and manufactured as one unit, shipped to the job site in one piece. The unit must incorporate the following sections but not limited to:
- A) Supply air fan section.
 - B) Fresh air filter section.
 - C) Fresh air inlet damper.
 - D) Packaged refrigeration system.
 - E) Gas heating section.
 - F) Condenser reheat section.

Reference: the specification for the capacities on each item.

- 1.4 Units assembled to achieve a close proximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as ETL, UL, prior to shipment.
- 1.5 Prewired air handling units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
- 1.6 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.
- Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.
 - Factory installed and wired non-fused disconnect switch in CEMA/NEMA 1 (weatherproof) configuration, or disconnect with integral door closure mounted on face of control panel.
- 1.7 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.
- 1.8 Manufacturer shall have a fully implemented and audible quality assurance program, equal to the ISO-9002 Quality Standard.

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OUTSIDE AIR UNIT (DX) – PACKAGED ROOFTOP ASSEMBLY

- 1.9 Air Handling Units shall be as manufactured by Engineered Air or pre approved equal. Alternate products must show savings and clearly indicate all areas where they do not meet specified product.

2 UNIT CONSTRUCTION

- 2.1 Unit casing shall be of minimum 18 gauge satin coat galvanized sheet metal, double wall construction. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer c/w Epoxy Paint Under coat. Finish coat shall be a topcoat of Polyurethane UV protected Paint, applied to all exposed surfaces. All unprotected metal and welds shall be factory coated.
- 2.2 All walls, roofs and floors shall be of formed construction; with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall joints shall be broken in and, on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant.
- 2.3 The following components shall be provided with a 22 gauge (.85 mm) solid liner over insulated areas:
- Fan Sections
 - Coil Sections
 - Filter Sections
 - Inlet Sections
 - Access Sections
 - Underside of Unit
- 2.4 Units shall be provided with access doors to the following components: fans and motors; filters; dampers and operators; access plenums electrical control panels; compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

Access door construction to be 2" thick double wall door, pressure injected with 2.2 pounds of polyurethane foam per cubic foot. A extruded aluminum perimeter framing with steel sheets front and back bond with the polyurethane to create a seamless rigid panel with a insulating value of R13. The thermal door to use a high-density polyurethane insulation. The frame to be fabricated from aluminum extrusions. All gasket to be proprietary Santoprene design press fitted into the frame slots allowing for easy field replacement. Each door is complete with a minimum of two stainless steel hinges and two-lever lock handles.

Lift out access panels either bolted or secured with two or more camlock fasteners must be provided in locations where non-regular access would be beneficial.

- 2.5 Casings shall be supported on structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.
- 2.6 All units shall be internally insulated with
- 2" (50 mm) thick nominal 3 lb./cu.ft. (48 kg./cu.m.) density acoustic insulation. Nominal 3 lb/cu.ft. (48 kg/cu.m.) Insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

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OUTSIDE AIR UNIT (DX) – PACKAGED ROOFTOP ASSEMBLY**

- 2.7 Cooling coil drain pans shall be fabricated of stainless steel and are an integral part of the floor paneling, a minimum of 2" (50 mm) deep, with welded corners. Drain pans shall extend a minimum of 6" (300 mm) downstream of coil face and be provided with a 1 ½ " (38 mm) S.S. M.P.T. drain connection. Drain pans must have a fast pan & be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.
- 2.8 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain into the unit, louvers or hoods on air intakes and exhaust openings with 1" (25 mm) galvanized inlet screens; rain gutters or diverters over all access doors' all joints caulked with a water resistant sealant; roof joints turned up 2" (50 mm) with three break interlocking design; outer wall panels extend a minimum of ¼ inch (6 mm) below the floor panel; drain trap(s) connections for field supply & installation of drain traps.
- 2.9 Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.
- 2.10 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 16 inches high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25 mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof-mounting curb shall be provided by the Roofing Subcontractor. Continuous structural support of curb by others.

3 FANS

- 3.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be provided with a rust inhibiting coating.
- 3.2 Single low-pressure Airfoil fans shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.
- 3.3 Drives shall be adjustable on fans with motors 5 HP (3.73 kW) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
- 3.4 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.
- 3.5 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1" (25 mm) static deflection designed to achieve high isolation efficiency. Use of separate bumper or snubber is not acceptable.) Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

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- 3.6 Fan motors shall be Super high efficiency, ODP type.

4 **COILS**

- 4.1 Coils shall be ½" O.D. as manufactured by Engineered Air, constructed of Copper tube, Aluminum fin, copper headers with copper distributors.

Fins constructed of aluminum shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a stainless steel casing. All coils shall be factory tested with air at 300 psig while immersed in an illuminated water tank.

- 4.2 Distributors and refrigerant specialties shall be enclosed and outside the airstream and accessible through a full size access door. The non-headered end of the coil shall be fully concealed. Provide auxiliary drain pan complete with ½" (13 mm) MPT drain connection at headered end of cooling coils.
- 4.3 Refrigerant evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Where a hot gas bypass is required, the inlet shall be at the refrigerant distributor. Solenoid valves, expansion valves, and related accessories are to be provided and installed by the refrigeration contractor.
- 4.4 Refrigerant coils with multiple compressors shall be alternate tube circuited (Interlaced) in order to distribute the cooling effect over the entire coil face at reduced load conditions. Provision for use of thermal expansion valves must be included for all applications.

5 **FILTERS**

- 5.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.

- 5.2 The filter modules shall be designed to slide out of the unit. Side removal 2" filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.

- 5.3 Pleated Panel Disposable Filters:

2" Non-woven cotton and synthetic fabric media with a metal support grid and rigid heavy-duty board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Permanent re-usable metal enclosing frame. The filter media shall have an efficiency of 30% on ASHRAE Standard 52.1-92, and minimum MERV 6 per ASHRAE 52.2.-1999.

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6 **DAMPERS**

6.1 Dampers shall be:

Fresh air:

Low Leakage damper certified under the AMCA Certified Ratings program. The blades shall be 14 gage galvanized steel, rollformed airfoil type for low pressure drop and low noise generation. Blade edge seals shall be ruskiprene type or equivalent, mechanically locked into the blade edge. Jamb seals shall be flexible metal, compression type to prevent leakage between blade edge and the damper frame. Bearings shall be corrosion resistant, permanently lubricated stainless steel sleeve type turning in an extruded hole in the damper frame. Axles shall be square or Hexagonal positively locked into the damper blade. Dampers are to be equivalent to Engineered Air Low Leak Dampers.

7 **MECHANICAL COOLING**

7.1 Compressors

Compressors shall be hermetic type, 3600 RPM, set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.

7.2 Air Cooled Condenser

Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

Condenser fans shall be direct driven propeller type arranged for vertical draw through air flow. Motors shall be weather resistant type, with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted on a formed orifice plate for optimum efficiency with minimum noise level.

Condenser to form an integral part of the unit.

- Control panel shall be equipped with a dead-front non-fused disconnect switch.

Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, control circuit transformer, cooling relays, non-recycling pumpdown relays, ambient compressor lockout, manual reset high pressure controls and automatic reset low pressure controls. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

Provide five minute anti-cycle timers.

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Provide interstage time delay timers.

Provide hot gas bypass connection on the lead compressor.

Provide separate compressor compartment complete with 1" (25 mm) 1-1/2 lb. (24 kg/cu.m.) insulation and hinged access doors (40 tons and larger).

7.3 Packaged Air Conditioning Units

Packaged units shall operate down to 50°F (10°C) as standard. Where applicable, multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with liquid line filter-driers, and service ports fitted with Schraeder fittings. Units with over 6 Ton hermetic compressors shall also incorporate load compensated thermal expansion valves with external equalizers and combination sight glass moisture indicators. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.

Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, supply fan contactors and overload protection control circuit transformer, cooling relays, ambient compressor lockout, automatic reset low pressure controls, and high pressure controls on compressors over 5 tons. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

Unit shall have a minimum of 5 compressors with 5 independent circuits.

7.4 Cooling Control

7.4.4 Electronic

Engineered Air C-TRAC electronic temperature control system with the capability of providing up to 5 stages of cooling control to maintain discharge (room) temperature. The minimum run and off time for compressors shall be 4 minutes at full load startup, and may range up to 8 minutes under part load conditions. The C-TRAC shall incorporate a PI (proportional/integral) control scheme that reduces temperature droop by resetting to the set point after each stage is cycled on. C-TRAC shall include:

7.5 CONDENSER REHEAT COIL:

Provide unit with integral mounted condenser reheat coil, as sized in the schedule for condenser reheat.

The condenser reheat coil is to be constructed the same as the DX coil.

The condenser Reheat coil is to be controlled via on/ off control from an adjustable ambient temperature switch.

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8 GAS HEAT SECTION (DJ, DJE) – Indirect Fired

8.1 General

- 8.1.1 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority, and carry the approval label of that authority as a complete operating package.
- 8.1.2 All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire.
- 8.1.3 Operating natural gas pressure at unit(s) manifold shall be 7" (1750 Pa) w.c.

8.2 Heat Exchanger

- 8.2.1 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane tubulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1" (25 mm) of insulation between the outer cabinet and inner liner. Blower assemblies close coupled to duct furnace type heat exchangers are not acceptable.
- 8.2.2 Units with optional high efficiency heat exchangers (DJ) shall be tested and certified to ANSI standards to provide a minimum of 80% efficiency throughout the entire operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

8.3 Burner

- 8.3.1 The burner assembly shall be a blow through positive pressure type with an intermittent pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay c/w flame rod. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner. Atmospheric burners, or burners requiring power assisted venting are not acceptable.
- 8.3.2 Unit(s) incorporating discharge air control and wherever specified, shall include 15:1 turndown (HT burner). The high turndown burner minimum input shall be capable of controlling at 6.7% of its rated input without on-off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from hi to lo fire.

8.4 Controls

- 8.4.4 Electronic DJM (Modulating Fuel w/ Modulating Combustion Air)

Solid state analyzer complete with proportional and integral control and with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Combustion air

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motor speed varies in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions.

Combustion efficiency of 80% standard efficiency heat exchangers shall increase 4 – 5% from high fire to low fire on units incorporating 15:1 turndown (HT Burner). Heat exchangers shall provide a minimum of 78% (DJ) efficiency throughout the entire operating range.

Controllers for heating units only shall include the following standard features:

- linear gas and combustion air flow obtained via a built in solid state linear algorithm
- -40°F (-40°C) minimum operating ambient temperature
- four (4) air change pre-purge on units with over 400 MBH (117 kw) input
- post purge
- interrupted pilot
- self check on start-up to make sure air proving and discharge air sensors are operating within design tolerances
- low fire start
- controlled burner start-up and shut down
- diagnostic lights for ease of set-up and service
- blower contactor that starts fan after burner pre-purge
- damper contact that allows fan to start after damper opens, damper to close after fan stops and damper to close on flame failure
- non-recycling auto by-pass low limit that has built-in sensor checking
- built-in alternate blower and damper functions and set back temperatures for unoccupied mode operation using a single room thermostat

Heating control function shall be:

Modulating discharge air complete with sensor and intergral selector.

SECTION 15838
DX Cooling Air Handling Units

PART 1. GENERAL**1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1 - General Requirements and referenced documents.
- B. Comply with all other Division 15 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 air handling unit's 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 15010.

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 15010.

PART 2. PRODUCTS**2.1 EQUIPMENT:**

- A. General: Unit shall be factory assembled, single-piece central-station air-handler. Unit shall consist of a fan and coil section with a factory-installed direct-expansion coil.
- B. Unit Cabinet: Unit panels shall be constructed of milled galvanized steel. Casing panels shall be removable for easy access to the unit. Hinged access door shall be double wall with 1.5 lb. dual density fiberglass between galvanized steel panels. Insulation for casing panels on unit shall be 1-in. minimum thickness dual-density fiberglass insulation with a density of not less than 1.5 lb. per cubic foot. Insulation shall be secured to casing with water-proof adhesive. Sloped, self-draining condensate drain pans shall have double-wall construction with threaded drain connection.
- C. Fan Section: Fan sections shall be constructed of galvanized steel and have a formed channel base for integral mounting of fan, motor, and casing panels. Fan scroll, wheel, shaft, and bearings shall be rigidly secured to the unit base. Fans shall be double width, double inlet type, with forward-curved blades. Wheels shall be bonderized steel painted

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DX Cooling Air Handling Units

with baked enamel, or galvanized steel. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed, and shall be statically and dynamically balanced as an assembly. Fan shafts shall be solid steel, turned, ground, and polished. Fan bearings shall be self-aligning, pillow block regreasable ball type selected for an average life of 200,000 hours at design operation conditions; per ANSI/AFBMA Standard 9-1978. Fan motor shall be mounted within the fan section casing on slide rails having 2 adjusting screws. Motor shall be NEMA Design B with sizes and electrical characteristics as shown on the equipment schedule. Fan drive shall be designed for a 1.3 service factor and shall be factory mounted and aligned. Belt drive shall be variable for fixed-pitch type.

- D. Coil Sections: All coils shall have mill galvanized steel casings. Coil performance shall be certified in accordance with ARI Standard 410. Direct-expansion coils shall have aluminum plate fins with belled collars bonded to 1/2-in. OD copper tubes by mechanical expansion. Coils shall be provided with pressure-type brass distributors with solder-type connections and shall have a minimum of 2 distributors. Coils for full face active or face split operation shall have intertwined circuits for equal loading of each circuit. Suction and discharge connections shall be on the same end. After testing, coils shall be dehydrated and charged with dry air.
- E. Condensate drain pan shall have double wall construction with threaded drain connections on both sides and shall extend under the complete long coil section of the horizontal, vertical draw-thru units. On single coil horizontal drawthru units with short coil sections, drain pan shall extend under complete fan and coil section.
- F. Motors shall be open drip proof 480 volt, 3-Phase, 60-Hz, 1750rpm.
- G. Accessories: Provide the following:
 - 1. Low-velocity filter sections shall be capable of accepting standard x 2-in. (nominal) filters accessible from either side. Provide low-velocity filter section with hinged access doors on both sides.
 - 2. Provide auxiliary drain pan under unit. Pipe thru wall to exterior dry wall. Dry wall shall be 18" deep x 12" round filed with 3/4 A gravel.
 - 3. Provide unit with discharge plenum and return air grill accessories.

2.2 SMOKE DETECTORS:

- A. Smoke detectors shall be provided for all units and /or smoke dampers as required by the governing authorities and as specified specifically in Division 16 Fire Alarm Section.
- B. Wiring of all smoke detectors shall be installed by a licensed electrician as covered in Division 16.
- C. It is the contractors responsibility to properly coordinate the smoke detectors and the subsequent wiring /control, and alarm system in order to provide the owner with a complete operational system meeting the requirements as set forth by the governing authority or authorities having jurisdiction.

2.3 CONTROLS:

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- A. Provide each unit with system electronic programmable thermostats, minimum 2 stage.

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Install central station air handling units as recommended by the unit manufacturer and as shown on the drawings.
- B. Adjust fan drives as directed to obtain scheduled capacities.
- C. Air handling unit shall be suspended vertically mounted. Refer to structural support attachment.

3.2 CLEANUP:

- A. Clean coils and condensate pans after installation of air conditioning units is complete.
- B. Clean all debris from inside air conditioning unit casings and other fan casings.

END OF SECTION

**SECTION 15861
CENTRIFUGAL FANS****PART 1. GENERAL****1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1 - General Requirements and referenced documents.
- B. Comply with all other Division 15 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 15010.

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 15010.

PART 2. PRODUCTS**2.1 EQUIPMENT:**

- A. General:

Fans shall be furnished complete with motor and pre-wired 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 16.

- 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

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CENTRIFUGAL FANS**

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 Shaft shall be of hot rolled steel shaft stock ground and polished to correct tolerance to prevent slipping or shaft cutting by fan wheel or drive sheave. Fan wheel shall be keyed to shaft and secured with a minimum of 2 set screws. Drive end of shaft shall be milled and fitted with key at factory.
 5. 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 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.
 6. 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. Ceiling Mounted Centrifugal Exhausters:
1. Exhausters shall be direct driven. Fan shall be selected on basis of maximum efficiency. Fan shall not exceed 80% of first critical speed when operating at maximum speed. Maximum speed shall not exceed 1050 rpm.
 2. Rotating unit of each fan shall be statically and dynamically balanced at factory for vibration-free performance through maximum catalog rated speed.
 3. Fan wheel shall be fabricated from dieformed or molded metal.
 4. Unit shall be set on resilient mountings and shall include backdraft damper, discharge duct mounting collar, and ceiling grille.
- D. 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

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CENTRIFUGAL FANS**

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 airfoil, and non-over loading type. Inlet orifices shall be deep, spun venturi type for high efficiency and non-turbulent air entrance condition.
 5. Fan Shaft shall be of hot rolled steel shaft stock ground and polished to correct tolerance to prevent slipping or shaft cutting by fan wheel or drive sheave. Fan wheel shall be keyed to shaft and secured with a minimum of 2 set screws. Drive end of shaft shall be milled and fitted with key at factory.
 6. 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.
 7. 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.
 8. 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.
 9. Fans shall bear the AMCA Certified Rating Performance Seal for both air and sound performance.
- H. Acceptable Manufacturers
1. Greenheck
 2. Cook
 3. Others as approved by the Engineer

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Install all centrifugal fans per manufacturer's recommendations, contract documents and approved shop drawings.

END OF SECTION

**SECTION 15880
AIR DISTRIBUTION SYSTEM**

PART 1. GENERAL**1.1 RELATED REQUIREMENTS:**

- A. Requirements of Regulatory Agencies: Comply with the applicable codes and standards listed in Section 15010 - GENERAL PROVISIONS.
- B. General Requirements: Comply with the requirements of Section 15010 - GENERAL PROVISIONS.

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 15010 - GENERAL PROVISIONS.

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,

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AIR DISTRIBUTION SYSTEM**

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.
 2. Reinforcing: Reinforcing bars and angles shall be of the same material as ducts on which they are used.

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.
 3. It is not intended for this specification to indicate each and every item noted in the SMACNA manual. It is the contractors responsibility to ascertain the requirements as set forth in the SMACNA manual in order to provide the Owner with a complete and operational duct system in compliance with the Standards indicated by SMACNA.
- 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

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All medium pressure ductwork, systems operating above 21/2 " inch W.G. or above 2500 FPM velocity shall be fabricated and installed in accordance to SMACNA standard Refer to the SMACNA manual for metal gauges, hangars, and recommendations.

- 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 sheetmetal ductwork shall be externally sealed using United McGill duct sealer, polymeric rubber with high solids content, low flame and smoke rating ,or approved equal from Ductmate industries .Duct sealer shall be installed in the joints prior to closure. Additionally seal all external transverse joints and fitting connections externally.
- I. Plenum chambers shall be constructed of 18 gauge sheets thoroughly braced with 1-1/2 inch angle irons. All duct panels in rectangular galvanized steel ducts which are 12 inches and wider and which are not lined shall be cross broken.
- J. **Fume Hood Ductwork.** Provide fume hood exhaust ductwork of No. 20 U.S. Gage, Type 302 stainless steel. Furnish circular ducts and gored elbows having a centerline radius of twice the diameter except where space conditions prohibit. All joints to be welded. Provide required transitions from duct to equipment and make equipment connections with drawbands. Install ducts with an upward grade in the direction of flow. Make the grade a minimum of 1/8-inch per foot. Low places in the duct that can collect moisture will not be allowed.
- K. **Grease Ductwork.** Ductwork removing grease-laden vapors such as those from cooking equipment should be listed grease ducts acceptable to the authority having jurisdiction, or 16-gage black steel, with liquid-tight continuous external weld on all seams and joints,

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complying with NFPA 96 and IMC 2006.

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 fabricated assembly consisting of an outer vapor barrier jacket of non-toxic polyolefin, a uniform layer of fiberglass insulation and a high-strength steel helix encapsulated in a polyester 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 polyolefin 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:

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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, or approved equal by the Engineer. Alternate manufacturers must meet Titus' specifications to be considered.

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. Provide height of blade as near the height of duct as possible with enough clearance to prevent scraping or binding.
 3. 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.
 4. 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.

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- 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.

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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 standard free area as indicated as Type B (high hat dampers for all supply and return applications .
3. Fire dampers for round duct shall have frames with 100% Smacna approved 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. Refer to Div 16 for fire alarm requirements and sequencing .
 - 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:

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- 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 air handling units (ahus), including roof exhausters, flexible connectors shall be made using "Ventglass" fabric 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 sheetmetal 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

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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. Coordinate with architectural drawings for ceiling types .
- 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.

**SECTION 15880
AIR DISTRIBUTION SYSTEM**

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. Where required and or indicated on the contract documents , the entire supply and return ductwork shall be tested utilizing the SMACNA approved testing procedure indicating testing apparatus , test areas and the amount of leakage determined by SMACNA methods . Contractor shall submit this report indicating full compliance in accordance to ASHRAE and SMACNA standards direct to the engineer upon request.

END OF SECTION

**SECTION 15940
ROOF MOUNTED AIR INLETS AND OUTLETS**

PART 1. GENERAL**1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1 - General requirements and referenced documents.
- B. Comply with Division 15 Sections, as applicable. Refer to other Divisions for coordination of work with other trades, as required.

1.2 DESCRIPTION:

- A. Provide air inlets and relief vents as indicated on Drawings, complete with prefabricated curbs, and as specified herein.

1.3 QUALITY ASSURANCE:

- A. Applicable Standards: Conform to the following:
 - NFPA-90A: Standard for the Installation of Air Conditioning and Ventilating Systems.
 - AMCA: Interim Standard Test Code for Roof Inlets and Outlets.

1.4 SUBMITTALS:

- A. Submit manufacturer's literature, engineering data, and shop drawings in accordance with the requirements of Section 15010 - GENERAL PROVISIONS.
- B. Installation and Operating Instructions: Submit installation and instruction manual, complete with a description of all installation, operation and maintenance instructions. All factory inspection and operational test reports shall be included with the manuals.
- C. Recommended Spare Parts Lists: Submit list of recommended spare parts for all items covered by this specification. Include description of parts, part numbers, price of each part and a minimum of three (3) locations where parts can be obtained.

1.5 PRODUCT HANDLING, DELIVERY AND STORAGE:

- A. Delivery, handling and storage of materials covered by this specification shall comply with the requirements of Section 15010 - GENERAL PROVISIONS.
- B. Delivery: Receive, unload and deliver materials to installation site, or to storage, and then installation site. Inspect materials when they are received and immediately report any damage or shortage.
- C. Storage: Roof inlets and outlets, which cannot be installed immediately after delivery, are to be stored in a safe, dry location. Protect stored products from damage or loss.
- D. Handling: Remove protective caps or coverings at time of installation and check air passage for cleanliness. Remove obstructions as required.

1.6 GUARANTEE:

**SECTION 15940
ROOF MOUNTED AIR INLETS AND OUTLETS**

- A. Products and workmanship specified in this section of the specification shall comply with the guarantee requirements of Section 15010 - GENERAL PROVISIONS.

1.7 JOB CONDITIONS:

- A. Protection of existing roof structure or roofing: Take all necessary precautions when installing roof inlets and outlets in order not to damage roof structure or roofing. Any such damage will be responsibility of Contractor to repair and/or replace.

PART 2. PRODUCTS

2.1 MATERIALS - RELIEF VENTS:

- A. Provide 0.080 inch thick extruded aluminum Skymaster Model EV relief vents complete with built-in bird screens. Miter and continuously weld all corners, and grind all welded joints smooth.
- B. Locations and sizes shall be as shown on Drawings.
- C. Relief vents shall include motor operated dampers connective linkage. Dampers shall be all aluminum construction with each damper blade supported by nylon bearings for smooth operation, and felt edges.

2.2 MATERIALS - AIR INLETS:

- A. Provide 0.080 inch thick extruded aluminum Skymaster Model IV air inlets complete with built-in bird screens. Miter and continuously weld all corners, and grind all welded joints smooth.
- B. Locations and sizes shall be shown on Drawings.

2.3 MATERIALS - PREFABRICATED CURBS:

- A. Provide air inlets and outlets with prefabricated Acme Model SF curbs.
- B. Fabricate curbs from heavy gauge galvanized steel, all welded, watertight.
- C. Curbs shall be acoustically lined and thermally insulated with 1-1/2" thickness of fire resistant glass fiber. Provide foam rubber gasket on full perimeter of curb top side. Height: 12 inches.

2.4 MANUFACTURERS:

- A. Relief vents and air inlets specified herein shall be Skymaster as manufactured by Acme Engineering Manufacturing Corp. The following manufacturer's products of equal substance, function and performance may be acceptable subject to review by Owner's Representative:

Greenheck
Cook
Penn

PART 3. EXECUTION

3.1 INSTALLATION:

**SECTION 15940
ROOF MOUNTED AIR INLETS AND OUTLETS**

- A. Install roof inlets, roof outlets and prefabricated curbs to conform to Drawings, reviewed shop drawings and manufacturer's instructions and recommendations.

END OF SECTION

**SECTION 15941
WALL LOUVERS****PART 1. GENERAL****1.1 RELATED REQUIREMENTS:**

- A. Comply with Division 1 - General requirements and referenced documents.
- B. Comply with Division 15 Sections, as applicable. Refer to other divisions for coordination of work with other trades, as required.

1.2 DESCRIPTION:

- A. This Section covers exterior stationary storm proof louvers complete as shown on the drawings and specified herein.
 - 1. Provide accessories, anchorage devices, and other items essential to complete the louver installation, though not specifically indicated or specified.

1.3 QUALITY ASSURANCE:

- A. Applicable Standards: Conform to the following:
 - 1. Louvers shall bear the AMA Certified Rating Seal.

1.4 SUBMITTALS:

- A. Submit manufacturer's literature, engineering data and shop drawings in accordance with the requirements of Section 15010 - GENERAL PROVISIONS.
- B. Submittal data and shop drawings shall include but not be limited to:
 - 1. Materials of construction.
 - 2. Installation details.
 - 3. Sizes.
 - 4. Color.

1.5 PRODUCT HANDLING, DELIVERY AND STORAGE:

- A. Delivery, handling and storage of materials covered by this specification shall conform to the requirements of Section 15010 - GENERAL PROVISIONS.

1.6 GUARANTEE:

- A. Products and workmanship specified in this section of the specification shall comply with the Guarantee Requirements of Section 15010 - GENERAL PROVISIONS.

PART 2. PRODUCTS**2.1 MATERIALS:**

- A. Aluminum fixed blade louvers:

**SECTION 15941
WALL LOUVERS**

1. Louvers shall be extruded aluminum, stationary stormproof type, with a drain gutter in each blade. Blades and frames shall be minimum 0.1 inch thick with reinforcing bosses and shall be of 6063-T5 alloy. Head, jamb and sill shall be of one piece structural member of 6063-T5 Alloy with integral calking slot and retaining bead. Supports and blades shall have provision for expansion and contraction. All fastenings shall be stainless steel or aluminum. Louvers shall be free of all scratches, blemishes and defects. Sizes shall be as shown on the Drawings. Louvers shall have a minimum free area of 50% and a maximum pressure drop of 0.02 inches of water at 500 feet per minute air velocity.
2. Structural supports shall be provided and designed by the louver manufacturer to carry a windload of not less than thirty-five pounds per square foot (35 psi).
3. Provide louvers with removable bird screens, consisting of aluminum frame with mitered corners and 0.063 inch (1.6 mm) diameter 1/2 inch aluminum wire mesh. Bird screen shall be attached to interior of louver with sheet metal screws or clips.
4. Provide backdraft dampers adjacent to each wall louver in all cases with exception of louvers that provide the introduction of combustion air.
5. Louver finish shall be as directed by Architect.
6. Acceptable Manufacturers: Ruskin, Construction Specialties, Airlite, American Warming and Ventilating, Greenheck, or approved equal.

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Installation shall be in strict accordance with the drawings, approved shop drawings and manufacturer's instructions and recommendations.

END OF SECTION

**SECTION 15959
DIRECT DIGITAL CONTROLS SYSTEM**

1. Part 1 – General**Table of Contents****Part 1 – General**

- 1.1 Related Documents
- 1.2 Definitions
- 1.3 BMS System Description
- 1.4 Quality Assurance
- 1.5 References
- 1.6 Work By Others
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Part 2 – Products

- 2.1 General Description
- 2.2 System Architecture
- 2.3 User Interface
- 2.4 Network Automation Engine
- 2.5 Network Integration Engine
- 2.6 Network Control Engine
- 2.7 DDC System Controllers
- 2.8 Field Devices
- 2.9 System Tools
- 2.10 Input Devices
- 2.11 Output Devices
- 2.12 Miscellaneous Devices / Specialty Items

Part 3 – Execution

- 3.1 Installation Practices
- 3.2 Training
- 3.3 Commissioning Requirements
- 3.4 Coordination
- 3.5 Sequences
- 3.6 Point Lists

1.1 Related Documents

- A. All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.
- B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 15 Sections for details.
- C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- D. If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

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1.2 Definitions

- A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- B. Binary: A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level.
- C. Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor and to be interfaced to the associated work of other related trades.
- D. BMS Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work.
- E. Control Sequence: An BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.
- F. Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- G. BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.
- H. Node: A digitally programmable entity existing on the BMS network.
- I. BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.
- J. Provide: The term “Provide” and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- K. PC: IBM-compatible Personal Computer from a recognized major manufacturer
- L. Furnish: The term “Furnish” and its derivatives when used in this Division shall mean supply at the BMS Contractor’s cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.
- M. Wiring: The term “Wiring” and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.
- N. Install: The term “Install” and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- O. Protocol: The term “protocol” and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.

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- P. Software: The term “software” and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.
- Q. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- R. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.
- S. The following abbreviations and acronyms may be used in describing the work of this Division:

ADC	-	Analog to Digital Converter
AI	-	Analog Input
AN	-	Application Node
ANSI	-	American National Standards Institute
AO	-	Analog Output
ASCII	-	American Standard Code for Information Interchange
ASHRAE	-	American Society of Heating, Refrigeration and Air Conditioning Engineers
AWG	-	American Wire Gauge
CPU	-	Central Processing Unit
CRT	-	Cathode Ray Tube
DAC	-	Digital to Analog Converter
DDC	-	Direct Digital Control
DI	-	Digital Input
DO	-	Digital Output
EEPROM	-	Electronically Erasable Programmable Read Only Memory
EMI	-	Electromagnetic Interference
FAS	-	Fire Alarm Detection and Annunciation System
GUI	-	Graphical User Interface
HOA	-	Hand-Off-Auto
ID	-	Identification
IEEE	-	Institute of Electrical and Electronics Engineers
I/O	-	Input/Output
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
NC	-	Normally Closed
NIC	-	Not In Contract
NO	-	Normally Open
OWS	-	Operator Workstation
OAT	-	Outdoor Air Temperature
PC	-	Personal Computer
RAM	-	Random Access Memory
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference

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RH	-	Relative Humidity
ROM	-	Read Only Memory
RTD	-	Resistance Temperature Device
SPDT	-	Single Pole Double Throw
SPST	-	Single Pole Single Throw
XVGA	-	Extended Video Graphics Adapter
TBA	-	To Be Advised
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
VAC	-	Volts, Alternating Current
VAV	-	Variable Air Volume
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network

1.3 BMS Description

- A. The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- C. The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.
- D. The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
- E. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- F. Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- G. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

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1. Operator information, alarm management and control functions.
2. Enterprise-level information and control access.
3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
4. Diagnostic monitoring and reporting of BMS functions.
5. Offsite monitoring and management access.
6. Energy management
7. Standard applications for terminal HVAC systems.

1.4 Quality Assurance

A. General

1. The Building Management System Contractor shall be Johnson Controls, Houston Factory Branch Office. Call **Ryan Williams 512-461-1276** for quotes.
2. Franchise dealers are not acceptable. Johnson Controls Houston, Texas Factory Branch office is the only acceptable controls contractor.
3. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid.

B. Workplace Safety And Hazardous Materials

1. Provide a safety program in compliance with the Contract Documents.
2. The BMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
3. The Contractor and its employees and subtrades comply with federal, state and local safety regulations.
4. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA have jurisdiction for at least each topic listed in the Safety Certification Manual.
5. Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.
6. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
7. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.

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8. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.
9. The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

C. Quality Management Program

1. Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manger shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:
 - a. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
 - b. Manage the financial aspects of the BMS Contract.
 - c. Coordinate as necessary with other trades.
 - d. Be responsible for the work and actions of the BMS workforce on site.

1.5 References

- A. All work shall conform to the following Codes and Standards, as applicable:
1. National Fire Protection Association (NFPA) Standards.
 2. National Electric Code (NEC) and applicable local Electric Code.
 3. Underwriters Laboratories (UL) listing and labels.
 4. UL 864 UUKL Smoke Control
 5. UL 268 Smoke Detectors.
 6. UL 916 Energy Management
 7. NFPA 70 - National Electrical Code.
 8. NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.
 9. NFPA 92A and 92B Smoke Purge/Control Equipment.
 10. Factory Mutual (FM).
 11. American National Standards Institute (ANSI).
 12. National Electric Manufacturer's Association (NEMA).
 13. American Society of Mechanical Engineers (ASME).
 14. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) [user note: add ASHRAE 62 IAQ as applicable].
 15. Air Movement and Control Association (AMCA).
 16. Institute of Electrical and Electronic Engineers (IEEE).
 17. American Standard Code for Information Interchange (ASCII).
 18. Electronics Industries Association (EIA).

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19. Occupational Safety and Health Administration (OSHA).
 20. American Society for Testing and Materials (ASTM).
 21. Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.
 22. Americans Disability Act (ADA)
 23. ANSI/EIA 909.1-A-1999 (LonWorks)
 24. ANSI/ASHRAE Standard 195-2004 (BACnet)
- B. In the case of conflicts or discrepancies, the more stringent regulation shall apply.
- C. All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.6 Submittals

- A. Shop Drawings, Product Data, and Samples
1. The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
 2. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
 3. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.
 4. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
 5. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
 6. The BMS Contractor shall correct any errors or omissions noted in the first review.
 7. At a minimum, submit the following:
 - a. BMS network architecture diagrams including all nodes and interconnections.
 - b. Systems schematics, sequences and flow diagrams.
 - c. Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - d. Samples of Graphic Display screen types and associated menus.
 - e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
 - f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
 - g. Details of all BMS interfaces and connections to the work of other trades.

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- h. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.8 Record Documentation

A. Operation and Maintenance Manuals

- 1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
 - a. Table of contents.
 - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - c. Manufacturers product data sheets or catalog pages for all products including software.
 - d. System Operator's manuals.
 - e. Archive copy of all site-specific databases and sequences.
 - f. BMS network diagrams.
 - g. Interfaces to all third-party products and work by other trades.
- 2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

- B. On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server

1.9 Warranty

A. Standard Material and Labor Warranty:

- 1. Provide a one-year labor and material warranty on the BMS.
- 2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
- 3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

2. Part 2 – Products

2.1 General Description

- A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication

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protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

- B. The Building Management System shall consist of the following:
1. Standalone Network Automation Engine(s)
 2. Field Equipment Controller(s)
 3. Input/Output Module(s)
 4. Local Display Device(s)
 5. Portable Operator's Terminal(s)
 6. Distributed User Interface(s)
 7. Network processing, data storage and communications equipment
 7. Other components required for a complete and working BMS
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
 2. The System shall maintain all settings and overrides through a system reboot.
- E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
1. The System shall comply with the following International Code Council (ICC) Codes:
 - a. Building Officials and code Administrators International (BOMA) model code
 - b. International Conference of Building Officials (ICBO) model code
 - c. Southern Building Code Congress International (SBCCI) regulations
- F. Acceptable Manufacturers
- 1) Johnson Controls Factory Branch Office or approved equal.
 - a. Metasys Only
 - b. BACnet Protocol Only
 - c. Call Ryan Williams 512-461-1276 for Quotes
 - 2) Alternate manufacturers must be approved by the engineer of record at least 14 days prior to bid time. This approval letter must be submitted with bid. Failure to submit approval letter with bid will result in automatic disqualification of bid. Acceptable manufacturers must at least meet the following minimum qualifications prior to applying for acceptance to bid as an alternate: must be a factory office (franchise branches are not acceptable), been in business in the Houston area for a minimum of 25 years, and have a

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service department with the ability to respond in max 1 hour time period for service call. Voluntary alternate bids will not be accepted. All bidders must complete the process in order to qualify for bidding.

2.2 BMS Architecture

A. Automation Network

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.
2. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
3. Network Automation Engines (NAE) shall reside on the automation network.
4. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network

1. Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
 - a. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
 - ◇ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
 - b. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
 - c. The Johnson Controls N2 Field Bus.
2. Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The PICS shall be submitted 10 days prior to bidding.

2.3 User Interface

A. Dedicated Web Based User Interface

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1. Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
 - a. Microsoft Internet Explorer for user interface functions
 - b. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
 - c. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
 - d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries
3. PC Hardware – The personal computer(s) shall be configured as follows:
 - a. Memory – 1 GB (512 MB Minimum)
 - b. CPU– Pentium 4 processor. 2.8 Hz Clock Speed (2.0 GHz minimum)
 - c. Hard Drive – 80 GB free hard drive space (40GB minimum)
 - d. Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
 - e. CD ROM Drive – 32X performance
 - f. Ports – (2) Serial and (1) parallel, (2) USB ports
 - g. Keyboard – 101 Keyboard and 2 Button Mouse
 - h. CRT configuration – 1-2 CRTs as follows:
 - ◇ Each Display – 17” Flat Panel Monitor 1280 x 1024 resolution minimum
 - ◇ 16 bit or higher color resolution
 - ◇ Display card with multiple monitor support
 - i. LAN communications – Ethernet communications board; 3Comm or equal
4. Operating System Software
 - a. Windows XP Professional
 - b. Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
 - c. Provide software registration cards to the Owner for all included software.
5. Peripheral Hardware
 - a. Reports printer:
 - ◇ Printer Make – Hewlett Packard DeskJet
 - ◇ Print Speed – 600 DPI Black, 300 DPI Color
 - ◇ Buffer – 64 K Input Print Buffer
 - ◇ Color Printing – Include Color Kit

B. Distributed Web Based User Interface

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1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
 2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser supporting the following functions:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 3. Minimum hardware requirements:
 - ◇ 512 MB RAM
 - ◇ 2.0 GHz Clock Speed Pentium 4 Microprocessor
 - ◇ 100.0 GB Hard Drive.
 - ◇ 1 Keyboard with 83 keys (minimum).
 - ◇ SVGA 1024x768 resolution display with 64K colors and 16 bit color depth
 - ◇ Mouse or other pointing device
- C. User Interface Application Components
1. Operator Interface
 - a. An integrated browser based client application shall be used as the user operator interface program.
 - b. The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.
 - c. All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
 - d. The user interface software shall provide help menus and instructions for each operation and/or application.
 - e. The system shall support customization of the UI configuration and a home page display for each operator.
 - f. The system shall support user preferences in the following screen presentations:
 - ◇ Alarm
 - ◇ Trend
 - ◇ Display
 - ◇ Applications
 - g. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

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- h. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
 - ◇ User access for selective information retrieval and control command execution
 - ◇ Monitoring and reporting
 - ◇ Alarm, non-normal, and return to normal condition annunciation
 - ◇ Selective operator override and other control actions
 - ◇ Information archiving, manipulation, formatting, display and reporting
 - ◇ BMS internal performance supervision and diagnostics
 - ◇ On-line access to user HELP menus
 - ◇ On-line access to current BMS as-built records and documentation
 - ◇ Means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications
 - i. The system shall support a list of application programs configured by the users that are called up by the following means:
 - ◇ The Tools Menu
 - ◇ Hyperlinks within the graphics displays
 - ◇ Key sequences
 - j. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.
2. Navigation Trees
- a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
 - b. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
 - c. The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.
3. Alarms
- a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - ◇ Log date and time of alarm occurrence.
 - ◇ Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.

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- ◇ Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
 - ◇ Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
 - ◇ Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
 - ◇ Any attribute of any object in the system may be designated to report an alarm.
- b. The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
- c. The BMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.
- d. The BMS shall annunciate application alarms at minimum, as required by Part 3.
4. Reports and Summaries
- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
- ◇ All points in the BMS
 - ◇ All points in each BMS application
 - ◇ All points in a specific controller
 - ◇ All points in a user-defined group of points
 - ◇ All points currently in alarm
 - ◇ All points locked out
 - ◇ All BMS schedules
 - ◇ All user defined and adjustable variables, schedules, interlocks and the like.
- b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
- c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
- d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
5. Schedules
- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
- ◇ Weekly schedules
 - ◇ Exception Schedules
 - ◇ Monthly calendars
- b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

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- c. It shall be possible to define one or more exception schedules for each schedule including references to calendars
 - d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
 - e. Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
 - f. Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
 - g. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
6. Password
- a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
 - b. Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.
 - c. The system shall allow each user to change his or her password at will.
 - d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
 - e. A minimum of five levels of access shall be supported individually or in any combination as follows:
 - ◇ Level 1 = View Data
 - ◇ Level 2 = Command
 - ◇ Level 3 = Operator Overrides
 - ◇ Level 4 = Database Modification
 - ◇ Level 5 = Database Configuration
 - ◇ Level 6 = All privileges, including Password Add/Modify
 - f. A minimum of 100 unique passwords shall be supported.
 - g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
 - h. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
7. Screen Manager
- a. The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

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8. Dynamic Color Graphics
- a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
 - b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
 - c. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
 - ◇ All graphics shall be fully scalable
 - ◇ The graphics shall support a maintained aspect ratio.
 - ◇ Multiple fonts shall be supported.
 - ◇ Unique background shall be assignable on a per graphic basis.
 - ◇ The color of all animations and values on displays shall indicate if the status of the object attribute.
 - d. Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
 - e. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
 - ◇ The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
 - ◇ In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
 - f. Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
9. Historical trending and data collection
- a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
 - ◇ Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
 - Defined time interval
 - Upon a change of value
 - ◇ Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp.

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Points may be assigned to multiple history trends with different collection parameters.

- b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
 - c. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
10. Trend data viewing and analysis
- a. Provide a trend viewing utility that shall have access to all database points.
 - b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
 - c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
 - d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
 - e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
 - f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
 - g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.
 - h. The Display shall support the user's ability to change colors, sample sizes, and types of markers.
11. Database Management
- a. Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.
 - b. Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.
 - c. The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
 - ◇ Backup
 - ◇ Purge
 - ◇ Restore
 - d. The Database Manager shall support four tabs:
 - ◇ Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the Metasys Databases.

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- ◇ Maintenance – shall provide an easy method of purging records from the Metasys Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.
- ◇ Backup – Shall provide the means to create a database backup file and select a storage location.
- ◇ Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
- e. The Status Bar shall appear at the bottom of all Metasys Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:
 - ◇ Ready
 - ◇ Purging Record from a database
 - ◇ Action Failed
 - ◇ Refreshing Statistics
 - ◇ Restoring database
 - ◇ Shrinking a database
 - ◇ Backing up a database
 - ◇ Resetting internet information Services
 - ◇ Starting the Metasys Device Manager
 - ◇ Shutting down the Metasys Device Manager
 - ◇ Action successful
- f. The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.
- g. The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- h. The Monitoring Settings window shall have the following sections:
 - ◇ General – Shall allow the user to set and review scan intervals and start times.
 - ◇ Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
 - ◇ Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.
 - ◇ Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
 - ◇ Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.
- i. The Monitoring Settings Taskbar shall provide the following informational icons:
 - ◇ Normal – Indicates by color and size that all databases are within their limits.
 - ◇ Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.

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- ◇ Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.
 - j. The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
12. Demand Limiting and Load Rolling
- a. The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.
 - b. The System shall support both Sliding Window and Fixed Window methods of predicting demand.
 - c. The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.
 - ◇ Low Setting – Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.
 - ◇ Medium Setting – Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.
 - ◇ High Setting – Sheds loads earlier over a longer amount of time than the Medium Setting. Minimizes the probability of exceeding the Tariff Target.
 - d. The System shall have both a Shed Mode and a Monitor Only Mode of operation.
 - ◇ When the Shed Mode is engaged, the System shall actively control the Demand.
 - ◇ When the Monitor Mode is engaged, the System will simulate the shedding action but will not take any action.
 - e. The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.
 - f. The Demand Limiting program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
 - g. The Demand Limiting program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.
 - h. The System shall support a Maximum Shed Time for each load as determined by the user. The system shall restore the load before the Maximum Shed time has expired.
 - i. The System shall support a Minimum Shed Time for each load as determined by the user. The system shall not restore the load sooner than the Minimum Shed Time has expired.
 - j. The System shall support a Minimum Release Time for each load as determined by the user. The System shall not shed the load until it has been off for the Minimum Release time.
 - k. The System shall support three user defined options if the meter goes unreliable.

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- ◇ Shedding – The currently shed loads will be released as their Maximum shed Times expire.
 - ◇ Maintain the Current Shed Rate – The System will use the Demand Limiting shed rate that was present when the meter went unreliable.
 - ◇ Use Unreliable Meter Shed Rate – the system will control to a user defined Unreliable Shed Rate target.
- l. The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.
 - m. The Load Rolling program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
 - n. The Load Rolling program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.
 - o. The System shall provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.
 - p. The System shall provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:
 - ◇ Load is Offline
 - ◇ Load is Disabled
 - ◇ Load is Shed
 - ◇ Load is Locked
 - ◇ Load is in Comfort Override
 - q. The Load Summary shall include a Load Summary Runtime view listing the following load conditions:
 - ◇ Load Priority
 - ◇ Shed Strategy
 - ◇ Load Rating
 - ◇ Present Value
 - ◇ Ineligibility Status
 - ◇ Active Timer
 - ◇ Time Remaining
 - ◇ Last Shed Time
- D. Portable Operator Terminal
1. For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:
 - a. Personal Laptop Computer Manufacturer – Dell, Compaq or HP
 - b. 1 GB RAM (256 MB minimum) – XP Professional
 - c. 1.8 GHz Clock Speed Pentium 4 Microprocessor (800 MHz minimum)
 - d. 40 GB Hard Drive (40 GB minimum)
 - e. (1) CD-ROM Drive, 32x speed
 - f. (1) Serial (1) Parallel (2) USB ports
 - g. 1 Keyboard with 83 keys (minimum).

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- h. Integral 2 button Track Point or Track Ball.
 - i. 10” SVGA 1024x768 resolution color display
 - j. Two PCMCIA Type II or one Type III card slot
 - k. Complete operator workstation software package, including any hardware or software.
 - l. Original printed manuals for all software and peripherals.
 - m. Original installation disks or CD for all software, device drivers, and peripherals
 - n. Software registration cards for all included software shall be provided to the Owner.
 - o. Carrying case
 - p. Spare battery.
 - q. External power supply/battery charger
2. Proprietary Portable Terminal
- a. Manufacturers providing proprietary portable terminals shall submit technical data sheets for the terminal and all associated software and hardware.
 - b. The proprietary terminal shall meet the same operator interface software requirements as specified above.
3. Software
- a. Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.
 - b. When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.
 - c. When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.
- E. Ready Access Portal User Interface
- 1. BMS Contractor shall provide and install all computer hardware and software required to configure and consolidate all information and programs required for the delivery of a web accessible, task based portal to the BMS. This portal shall provide a natural, complementary extension to the Metasys site management user interface previously described.
 - 2. Computer Hardware (minimum) – The computer shall be configured as follows:
 - a. Memory – 2 GB (1 GB Minimum)
 - b. CPU– Pentium 4 processor, 2.8 Hz Clock Speed (2.0 GHz minimum)
 - c. Hard Drive – 200 GB free hard drive space (80 GB minimum)
 - d. Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
 - e. DVD ROM Drive – 16X performance
 - f. Ports – (1) Serial, (2) USB ports
 - g. Keyboard – 101 Keyboard and 2 Button Mouse
 - h. CRT configuration
 - ◇ 17” Flat Panel Monitor 1280 x 1024 resolution minimum
 - ◇ 16 bit or higher color resolution

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- i. LAN communications – Ethernet communications board; 100Mbps Min
3. Operating System Software
 - a. Windows XP Professional, IIS Version 5.1, .Net Version 2.0, SQL server 2005 Express software with SP2 or <Alternately> Microsoft Windows Server 2003 OS with SP2, IIS Version 6.0, .Net version 2.0 and SQL Server 2005 with SP2
 - b. Provide software and hardware required for integration of computing hardware on enterprise IT network.
 - c. Provide software registration cards to the Owner for all included software.
4. User Interface Application Components
 - a. The ready access portal shall provide an intuitive user interface to key Metasys functions and tasks via web browser.
 - b. Plug-ins or special software shall not be required for access to alarm, summary, schedule and trend data.
 - c. The system shall provide Secure Sockets Level (SSL) support. This allows the portal to communicate across a network in a way designed to prevent eavesdropping, tampering, and message forgery. It provides endpoint authentication and communications privacy over the network using cryptography.
 - d. The information shall be accessible on both personal computer and handheld device platforms as follows:
 - ◇ Personal computers – Internet Explorer Version 7.0 recommended
 - ◇ Handheld devices – Internet Explorer for Window Mobile Version 5.0 or 6.0 recommended. UI is optimized for devices with a 240 x 320 pixel screen size (QVGA). Other devices may display the UI but full functionality is not guaranteed.
5. Operator Interface
 - a. Password access shall be as described previously for management portal UI. self-configures by utilizing existing site management user interface configurations and access rights.
 - b. Once logged in, the System shall display a pre-selected screen tailored to the task requirements of the individual user.
 - c. The User Interface shall utilize an intuitive navigation and display method designed for operators who access the system for casual information and control or on an infrequent basis. It shall feature three basic components.
 - ◇ Function buttons for selection of the type of information to be displayed including Alerts, Summary, Schedules and Diagnostics
 - ◇ Navigation tree for selection of the specific data to be displayed on screen for the selected type, the navigation tree may be hidden and expanded by the operator to optimize the display of information
 - ◇ A display window that provides the selected information by type in a pre-configured tabular format
 - d. The user interface software shall provide help menus and instructions for each operation and/or application.
 - e. The system shall provide support for up to 100 concurrent users from an unlimited universe of individuals with defined password access to the system

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- f. The system shall have the capability to display multiple navigation trees that correspond to the user views configured in the management portal UI.

- g. The alert summary of the remote access portal shall, at the minimum, provide the following information
 - ◇ Alert (Alarm) type
 - ◇ Date and time of alert occurrence
 - ◇ Priority (color coded to level)
 - ◇ Item name
 - ◇ Item value (if applicable)
 - ◇ Message
 - ◇ Any attribute of any object in the system may be designated to report an alarm

- h. A standard summary on the remote access portal shall, at the minimum, provide the following information
 - ◇ Point type graphic icon
 - ◇ Item name
 - ◇ Item value
 - ◇ Item status
 - ◇ Access to the Change Value window (if applicable) for the purpose of setting, holding or releasing an item value

- i. The schedule detail summary of the remote access portal shall, at the minimum, provide the following information
 - ◇ Scheduled occurrences including time and value
 - ◇ Scheduled overrides including start time, end time and value
 - ◇ A list of all scheduled items including name and attribute, value, status and priority
 - ◇ Access to the Add Temporary Override window for the purpose of adding a temporary override to the schedule

- j. The diagnostic (trend) summary of the remote access portal as viewed on a personal computing device shall provide the following information.
 - ◇ Item name
 - ◇ Item status
 - ◇ Trend name
 - ◇ Trend status
 - ◇ Full path name
 - ◇ Access to trend detail summary including trended value, time and date arranged in a user selectable format of 1 hour, 12 hours, 24 hours, 48 hours or 72 hours

2.4 Network Automation Engines (NAE)

A. Network Automation Engine (NAE 3500)

- 1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed

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application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user’s personal computer are not acceptable.
 - b. The NAE shall support a minimum of two (2) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NAE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
 - e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
 - g. Systems that support UI Graphics from a central database or require the graphics to reside on the user’s personal computer are not acceptable.
 - h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 - i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power - On/Off

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- b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
 - c. Ethernet Connection Speed – 10 Mbps/100 Mbps
 - d. FC Bus – Normal Communications/No Field Communications
 - e. Peer Communication – Data Traffic between NAE Devices
 - f. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
 - g. Bat Fault – Battery Defective, Data Protection Battery Not Installed
 - h. Fault – General Fault
 - i. Modem RX – NAE Modem Receiving Data
 - j. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
- a. USB port
 - b. URS-232 serial data communication port
 - c. RS-485 port
 - d. Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
- a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support the following communication protocols on the controller network:
- a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - ◇ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
 - ◇ A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
 - ◇ The Conformance Statements shall be submitted 10 days prior to bidding.

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- ◇ The NAE shall support a minimum of 50 control devices.

2.5 DDC System Controllers

A. Field Equipment Controller (FEC X610)

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
 - a. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - ◇ The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - ◇ A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
 - ◇ The Conformance Statement shall be submitted 10 days prior to bidding.
2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The FEC shall include a removable base to allow pre-wiring without the controller.
6. The FEC shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power On
 - b. Power Off
 - c. Download or Startup in progress, not ready for normal operation
 - d. No Faults
 - e. Device Fault
 - f. Field Controller Bus - Normal Data Transmission
 - g. Field Controller Bus - No Data Transmission
 - h. Field Controller Bus - No Communication
 - i. Sensor-Actuator Bus - Normal Data Transmission
 - j. Sensor-Actuator Bus - No Data Transmission
 - k. Sensor-Actuator Bus - No Communication
7. The FEC shall accommodate the direct wiring of analog and binary I/O field points.

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8. The FEC shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - ◇ Analog Input, Voltage Mode
 - ◇ Analog Input, Current Mode
 - ◇ Analog Input, Resistive Mode
 - ◇ Binary Input, Dry Contact Maintained Mode
 - ◇ Binary Input, Pulse Counter Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - ◇ Dry Contact Maintained Mode
 - ◇ Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Analog Output, current Mode
 - d. Binary Outputs - shall output the following:
 - ◇ 24 VAC Triac
 - e. Configurable Outputs - shall be capable of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Binary Output Mode
9. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
 - a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - b. The FC Bus shall support communications between the FECs and the NAE.
 - c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
 - d. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
 - e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
 - f.
10. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
 - a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
 - b. The SA Bus shall support a minimum of 10 devices per trunk.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
11. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
12. The FEC shall support, but not be limited to, the following:
 - a. Hot water, chilled water/central plant applications
 - b. Built-up air handling units for special applications
 - C. Terminal units
 - c. Special programs as required for systems control

2.6 Field Devices

**SECTION 15959
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1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
2. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
3. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - c. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
 - d. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The IOM shall have a minimum of 4 points to a maximum of 17 points.
6. The IOM shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - ◇ Analog Input, Voltage Mode
 - ◇ Analog Input, Current Mode
 - ◇ Analog Input, Resistive Mode
 - ◇ Binary Input, Dry Contact Maintained Mode
 - ◇ Binary Input, Pulse Counter Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - ◇ Dry Contact Maintained Mode
 - ◇ Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following
 - ◇ Analog Output, Voltage Mode
 - ◇ Analog Output, current Mode
 - d. Binary Outputs - shall output the following:
 - ◇ 24 VAC Triac
 - e. Configurable Outputs - shall be capable of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Binary Output Mode
7. The IOM shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power On
 - b. Power Off
 - c. Download or Startup in progress, not ready for normal operation
 - d. No Faults
 - e. Device Fault
 - f. Normal Data Transmission
 - g. No Data Transmission

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h. No Communication

B. Networked Thermostat (TEC 26X6)

1. The networked thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters or other similar equipment.
2. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
5. The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
 - a. Two line, 8 character backlit display
 - b. LED indicators for Fan, Heat, and Cool status
 - c. Five (5) User Interface Keys
 - ◇ Mode
 - ◇ Fan
 - ◇ Override
 - ◇ Degrees C/F
 - ◇ Up/Down
 - d. The display shall continuously scroll through the following parameters:
 - ◇ Room Temperature
 - ◇ System Mode
 - ◇ Schedule Status – Occupied/Unoccupied/Override
 - ◇ Applicable Alarms
6. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral Indoor Air Temperature Sensor
 - b. Duct Mount Air Temperature Sensor
 - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
 - d. Two configurable binary inputs
7. The Networked Thermostat shall provide the flexibility to support any one of the following outputs:
 - a. Three Speed Fan Control
 - b. Two On/Off
 - c. Two Floating
 - d. Two Proportional (0 to 10V)
8. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.

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9. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - a. Adjustable Temporary Occupancy from 0 to 24 hours
 - b. Adjustable heating/cooling deadband from 2° F to 5° F
 - c. Adjustable heating/cooling cycles per hour from 4 to 8
10. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

C. Networked Thermostat (TEC 26X7)

1. The Networked Thermostat shall be capable of controlling a pressure dependant Variable Air Volume System or other similar zoning type systems employing reheat including local hydronic reheat valves.
2. The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Networked Thermostat shall be capable of remote read/write and parameter adjustment from the web based User Interface (UI) through an NAE.
5. The Networked Thermostat shall include an intuitive UI providing plain text messages.
 - a. Two line, 8 character backlit display
 - b. LED indicators for Heating, and cooling status
 - c. Three (3) User Interface Keys
 - ◇ Override
 - ◇ Up
 - ◇ Down
 - d. The display shall continuously scroll through the following parameters:
 - ◇ Room Temperature
 - ◇ System Mode
 - ◇ Schedule Status – Occupied/Unoccupied/Override
 - ◇ Applicable Alarms
6. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral Indoor Air Temperature Sensor
 - b. Duct Mount Air Temperature Sensor
 - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
 - d. Two configurable binary inputs
7. The Networked Thermostat shall provide the flexibility to support either of the following outputs:
 - a. Two On/Off or Floating

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- b. Two Proportional (0 to 10V)
 8. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
 9. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - a. Adjustable Temporary Occupancy from 0 to 24 hours
 - b. Adjustable heating/cooling deadband from 2° F to 5° F
 - c. Adjustable heating/cooling cycles per hour from 4 to 8
 10. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- D. Networked Thermostat (**TEC 26X5**)
1. The Networked Thermostat shall be capable of controlling a two pipe fan coil, cabinet unit heater or other similar equipment with single-speed fan control.
 2. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
 3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
 4. The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
 5. The Networked Thermostat shall be capable of remote read/write and parameter adjustment from the web based User Interface (UI) through an NAE.
 6. The Networked Thermostat shall include an intuitive UI providing plain text messages.
 - a. Two line, 8 character backlit display
 - b. LED indicators for Fan, Heat, and Cool status
 - c. Five (5) User Interface Keys
 - ◇ Mode
 - ◇ Fan
 - ◇ Override
 - ◇ Up
 - ◇ Down
 - d. The display shall continuously scroll through the following parameters:
 - ◇ Room Temperature
 - ◇ System Mode
 - ◇ Schedule Status – Occupied/Unoccupied/Override
 - ◇ Applicable Alarms
 7. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral Indoor Air Temperature Sensor
 - b. Duct Mount Air Temperature Sensor

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- c. Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
- d. Two configurable binary inputs
8. The Networked Thermostat shall provide the flexibility to support either of the following outputs:
 - a. One (1) fan control
 - b. One Proportional (0 to 10V)
9. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
10. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - a. Adjustable Temporary Occupancy from 0 to 24 hours
 - b. Adjustable heating/cooling deadband from 2° F to 5° F
 - c. Adjustable heating/cooling cycles per hour from 4 to 8
11. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

E. Network Sensors (NS-XXX700X)

1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - a. Zone Temperature
 - b. Zone Humidity
 - c. Zone Setpoint
 - d. Discharge Air Temperature
2. The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
3. The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Network Zone Sensors shall include the following items:
 - a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint
 - b. An LED to indicate the status of the Override feature
 - c. A button to toggle the temperature display between Fahrenheit and Celsius
 - d. A button to initiate a timed override command
 - e. Available in either surface mount or wall mount
 - f. Available with either screw terminals or phone jack
5. The Network Discharge Air Sensors shall include the following:
 - a. 4 inch or 8 inch duct insertion probe
 - b. 10 foot pigtail lead
 - c. Dip Switches for programmable address selection
 - d. Ability to provide an averaging temperature from multiple locations

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- e. Ability to provide a selectable temperature from multiple locations

F. Many-To-One Wireless Room Temperature Sensor System (WRS-XTX0000)

1. The Many-To-One System Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRS Sensors).
 - a. The WRS Receiver shall use direct sequence spread spectrum RF technology.
 - b. The WRS Receiver shall operate on the 2.4 GHZ ISM Band.
 - c. The WRS Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The WRS Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The WRS Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - f. The WRS Receiver shall be capable of communication with WRS Sensors up to a distance of 200 Feet.
 - g. The WRS Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - h. The WRS Receiver shall have LED indicators to provide information regarding the following conditions:
 - ◇ Power On/Off
 - ◇ Ethernet – Receiver Activity/No Activity
 - ◇ Wireless Normal Mode – Transmission from sensors/No Transmission
 - ◇ Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
 - ◇ Ethernet Connection – No connection/10Mbps connection/100Mbps connection
 - ◇ Network Activity – No Network Activity/Half-Duplex Communication/Full-Duplex Communication
2. The WRS Sensors shall sense and report room temperatures to the WRS Receiver.
 - a. The WRS Sensors shall use direct sequence spread spectrum RF technology.
 - b. The WRS Sensors shall operate on the 2.4 GHZ ISM Band.
 - c. The WRS Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The WRS sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The WRS sensors shall be available with
 - ◇ Warmer/Cooler Set Point Adjustment
 - ◇ No Set Point Adjustment
 - ◇ Set Point Adjustment Scale – 55 to 85° F.
 - f. The WRS sensors shall be assembled in NEMA 1 plastic housings.

G. ZFR1800 Series Wireless Field Bus System

1. The ZFR1800 Series System shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for Metasys BACnet devices at multiple system levels. This includes communications from FEC and VMA field

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controllers to sensors and from engines to these field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no additional software.

2. The ZFR1810 Wireless Field Bus Coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a ZFR1810 Coordinator for initiation and formation of the network
 - a. The ZFR Coordinator shall use direct sequence spread spectrum RF technology.
 - b. The ZFR Coordinator shall operate on the 2.4 GHZ ISM Band.
 - c. The ZFR Coordinator shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The ZFR Coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The ZFR Coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
 - f. The ZFR Coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
 - g. The ZFR Coordinator shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - h. The ZFR Coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
3. The ZFR1811 Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810 Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors.
 - a. The ZFR1811 Router shall use direct sequence spread spectrum RF technology.
 - b. The ZFR1811 Router shall operate on the 2.4 GHZ ISM Band.
 - c. The ZFR1811 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The ZFR1811 Router shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The ZFR1811 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
 - f. The ZFR1811 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
 - g. The ZFR1811 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - h. The ZFR1811 Router shall provide LED indication for use in commissioning and troubleshooting.
4. The WRZ-TT Series Wireless Room Temperature Sensors shall sense and transmit room temperatures, room set point, room occupancy notification and low battery condition to an associated ZFR1811 Router.
 - a. The WRZ sensors shall use direct sequence spread spectrum RF technology.
 - b. The WRZ sensors shall operate on the 2.4 GHZ ISM Band.

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- c. The WRZ sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The WRZ sensors shall operate on standard off-the-shelf AA batteries using alkaline technology.
 - e. The WRZ sensors shall provide LED indication for use in commissioning and troubleshooting.
 - f. The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - g. The WRZ sensors shall be available with
 - ◇ Warmer/Cooler Set Point Adjustment
 - ◇ No Set Point Adjustment
 - ◇ Set Point Adjustment Scale – 55 to 85° F.
 - h. The WRZ sensors shall be available with the capability to address with up to four unique addresses per controller.
 - i. The WRZ sensors shall be assembled in NEMA 1 plastic housings.
5. The ZFR Checkout Tool shall be provided to allow the installer to quickly check and document connectivity of the entire ZFR series wireless network, before leaving the jobsite.
- a. The ZFR Checkout Tool shall verify wireless network performance including online status verification and signal strength for all wireless connected devices.
 - b. The ZFR Checkout Tool shall provide a printed report detailing network and wireless device status.
 - c. The ZFR Checkout Tool shall be integrated with and operate as in integral part of the Controller Configuration Tool (CCT) specified elsewhere in this document.

2.7 System Tools

A. System Configuration Tool (SCT)

1. The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NIE).
2. The configuration tool shall provide an archive database for the configuration and application data.
3. The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.
4. The configuration tool shall include the following features:
 - a. Basic system navigation tree for connected networks
 - b. Integration of Metasys N1, LonWorks, and BACnet enabled devices
 - c. Customized user navigation trees
 - d. Point naming operating parameter setting

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- e. Graphic diagram configuration
 - f. Alarm and event message routing
 - g. Graphical logic connector tool for custom programming
 - h. Downloading, uploading, and archiving databases
5. The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
- a. BACnet Devices
 - b. LonWorks devices
 - c. N2 Bus devices
 - d. Metasys N1 networks
6. The configuration tool shall be capable of programming the Field Equipment Controllers.
- a. The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.
 - b. The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.
 - c. The configuration tool shall contain a library of standard applications to be used for configuration.
7. The configuration tool shall be capable of programming the field devices.
- a. The configuration tool shall provide the capability to configure, simulate, and commission the field devices.
 - b. The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.
 - c. The configuration tool shall contain a library of standard applications to be used for configuration
8. A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.
- a. The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).
 - b. The wireless use of configuration tool shall be the same as a wired connection in every respect.
 - c. The wireless connection shall use the Bluetooth Wireless Technology.
- B. Wireless MS/TP Converter (BTCVT)
- a. The converter shall provide a temporary wireless connection between the SA or FC Bus and a wireless enabled portable PC.
 - b. The converter shall support downloading and troubleshooting FEC and field devices from the PC over the wireless connection.
 - c. The converter shall employ Bluetooth Wireless Technology.
 - d. The converter shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
 - e. The converter shall operate over a minimum of thirty three (33) feet within a building.
 - f. The converter shall have LED indicators to provide information regarding the following conditions:
 - ◇ Power - On/Off

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- ◇ Fault – Fault/No Fault
 - ◇ SA/FC Bus – Bus Activity/ No Bus Activity
 - ◇ Blue – Bluetooth Communication Established/ Bluetooth Communication Not Established
- g. The SWCVT shall comply with FCC Part 15.247 regulations for low-power unlicensed transmitters.

C. Handheld VAV Balancing Sensor (ATV7003)

- a. The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.
- b. The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.
- c. The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
- d. The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.
- e. The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.
- f. The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.
- g. The sensor shall include the following
 - ◇ 5 foot retractable cable
 - ◇ Laminated user guide
 - ◇ Nylon carrying case
- h. The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

2.8 Input Devices

A. General Requirements

- 1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

- 1. General Requirements:
 - a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
 - b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
 - c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Room Temp	± .5°F.

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Point Type	Accuracy
Duct Temperature	$\pm .5^{\circ}\text{F}$.
All Others	$\pm .75^{\circ}\text{F}$.

2. Room Temperature Sensors
 - a. Room sensors shall be constructed for either surface or wall box mounting.
 - b. Room sensors shall have the following options when specified:
 - ◇ Setpoint reset slide switch providing a ± 3 degree (adjustable) range.
 - ◇ Individual heating/cooling setpoint slide switches.
 - ◇ A momentary override request push button for activation of after-hours operation.
 - ◇ Analog thermometer.
3. Room Temperature Sensors with Integral Display
 - a. Room sensors shall be constructed for either surface or wall box mounting.
 - b. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
 - ◇ Display room and outside air temperatures.
 - ◇ Display and adjust room comfort setpoint.
 - ◇ Display and adjust fan operation status.
 - ◇ Timed override request push button with LED status for activation of after-hours operation.
 - ◇ Display controller mode.
 - ◇ Password selectable adjustment of setpoint and override modes.
4. Outside Air Sensors
 - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
5. Duct Mount Sensors
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
6. Averaging Sensors
 - a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for

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stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.

- c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
7. Acceptable Manufacturers: Johnson Controls, Setra.

C. Humidity Sensors

1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
7. Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.

D. Flow Monitoring

1. Air Flow Monitoring
 - a. Fan Inlet Air Flow Measuring Stations
 - ◇ At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.
 - ◇ Each traverse probe shall be of a dual manifolded, cylindrical, type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm 20^\circ$ in the approaching air stream.
 - ◇ The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.

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- ◇ Airflow measuring stations shall be manufactured by Air Monitor Corp., Tek-Air Systems, Inc., Ebtron, or Dietrich Standard.
- b. Single Probe Air Flow Measuring Sensor
 - ◇ The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.
- c. Duct Air Flow Measuring Stations
 - ◇ Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
 - ◇ Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.
 - ◇ The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.
 - ◇ The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.
 - ◇ The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.
 - ◇ Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.
 - ◇ Installation Considerations
 - (i) *The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065" w.c. at 1000 feet per minute, or .23" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests, and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.*

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(ii) *The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.*

(iii) *Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.*

(iv) *Where control dampers are shown as part of the airflow measuring station, opposed blade precision controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.*

(v) *Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.*

◇ Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard.

d. Static Pressure Traverse Probe

◇ Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

◇ Acceptable manufacturers: Cleveland Controls

e. Shielded Static Air Probe

◇ A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

E. Power Monitoring Devices

1. Current Measurement (Amps)

a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.

◇ Operating frequency – 50 - 400 Hz.

◇ Insulation – 0.6 Kv class 10Kv BIL.

◇ UL recognized.

◇ Five amp secondary.

◇ Select current ration as appropriate for application.

◇ Acceptable manufacturers: Veris Industries

c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

◇ 6X input over amp rating for AC inrushes of up to 120 amps.

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- ◇ Manufactured to UL 1244.
- ◇ Accuracy: +.5%, Ripple +1%.
- ◇ Minimum load resistance 30kOhm.
- ◇ Input 0-20 Amps.
- ◇ Output 4-20 mA.
- ◇ Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
- ◇ Acceptable manufacturers: Veris Industries

F. Smoke Detectors

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 16 for installation under Division 15. All wiring for air duct detectors shall be provided under Division 16, Fire Alarm System.

G. Status and Safety Switches

1. General Requirements
 - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
2. Current Sensing Switches
 - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - d. Acceptable manufacturers: Veris Industries
3. Air Filter Status Switches
 - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
 - c. Provide appropriate scale range and differential adjustment for intended service.
 - d. Acceptable manufacturers: Johnson Controls, Cleveland Controls
4. Air Flow Switches
 - a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

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- b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 5. Air Pressure Safety Switches
 - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - c. Acceptable manufacturers: Johnson Controls, Cleveland Controls
- 6. Low Temperature Limit Switches
 - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
 - d. The low temperature limit switch shall be equal to Johnson Controls A70.

2.9 Output Devices

A. Control Relays

- 1. Control Pilot Relays
 - a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
 - b. Mounting Bases shall be snap-mount.
 - c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
 - d. Contacts shall be rated for 10 amps at 120VAC.
 - e. Relays shall have an integral indicator light and check button.
 - f. Acceptable manufacturers: Johnson Controls, Lectro

B. Electronic Signal Isolation Transducers

- 1. A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
- 2. The signal isolation transducer shall provide ground plane isolation between systems.
- 3. Signals shall provide optical isolation between systems.
- 4. Acceptable manufacturers: Advanced Control Technologies

C. External Manual Override Stations

- 1. External manual override stations shall provide the following:
 - a. An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.

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- b. A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
- c. A Status LED shall illuminate whenever the output is ON.
- d. An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.
- e. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

D. Electronic/Pneumatic Transducers

- 1. Electronic to Pneumatic transducers shall provide:
 - a. Output: 3-15 PSIG.
 - b. Input: 4-20 mA or 0-10 VDC.
 - c. Manual output adjustment.
 - d. Pressure gauge.
 - e. External replaceable supply air filter.
 - f. Acceptable manufacturers: Johnson Controls, Mamac

2.10 Miscellaneous Devices

A. Local Control Panels

- 1. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
- 2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
- 3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
- 4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
- 5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
- 6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies

- 1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
- 2. Input: 120 VAC +10%, 60Hz.
- 3. Output: 24 VDC.
- 4. Line Regulation: +0.05% for 10% line change.

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5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

C. Thermostats

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

3. Part 3 – Performance / Execution

3.1 BMS Specific Requirements

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .

B. Custom Reports:

1. Provide custom reports as required for this project:

C. Actuation / Control Type

1. Primary Equipment
 - a. Controls shall be provided by equipment manufacturer as specified herein.
 - b. All damper and valve actuation shall be electric.
2. Air Handling Equipment
 - a. All air handlers shall be controlled with a HVAC-DDC Controller
 - b. All damper and valve actuation shall be electric.
3. Terminal Equipment:
 - a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
 - b. All Terminal Units shall be controlled with HVAC-DDC Controller)

3.2 Installation Practices

A. BMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of

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applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.

2. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
 - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BMS Line Voltage Power Source

1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.
2. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
3. DDC terminal unit controllers may use AC power from motor power circuits.

C. BMS Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

D. Penetrations

1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.

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2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

E. BMS Identification Standards

1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

F. BMS Panel Installation

1. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
2. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

G. Input Devices

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BMS in accessible local control panels wherever possible.

H. HVAC Input Devices – General

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BMS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
 - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
 - b. Sensors shall be installed with a rain proof, perforated cover.
6. Air Flow Measuring Stations:
 - a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
 - b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
7. Duct Temperature Sensors:

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- a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
 - b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
 - c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
 - d. The sensor shall be mounted to suitable supports using factory approved element holders.
8. Space Sensors:
- a. Shall be mounted per ADA requirements.
 - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
9. Low Temperature Limit Switches:
- a. Install on the discharge side of the first water or steam coil in the air stream.
 - b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
10. Air Differential Pressure Status Switches:
- a. Install with static pressure tips, tubing, fittings, and air filter.

I. HVAC Output Devices

1. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.3 Training

- A. The BMS contractor shall provide the following training services:

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1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations. There will also be 40 Hours of Off-Site Training at the Johnson Controls Institute.

3.4 Commissioning

- A. Fully commission all aspects of the Building Management System work.
- B. Acceptance Check Sheet
 1. Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.
 2. Submit the check sheet to the Engineer for approval
 3. The Engineer will use the check sheet as the basis for acceptance with the BMS Contractor.
- C. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

3.5 Sequences

Multizone Air Handlers

JCI BMS to have the ability to start/stop and provide status on manufacturer multizone. Manufacturer provided controller will modulate all interior components to maintain setpoint of air streams. JCI zone t-stat will send 0-10v signal to multizones when call for cooling or heating is needed. Manufacturer provided controller will then modulate manufacturer provided zone dampers as required to maintain leaving air temperature. JCI will interact with manufacturer provided BACnet interface in order to provide manufacturer's desired points.

Single Zone DX RTU's

JCI BMS to have the ability to start/stop and provide status on JCI RTU. JCI zone t-stat will send signal to RTU for cooling or heating. JCI will interact with manufacturer provided BACnet interface in order to provide manufacturer's desired points.

100% OA Units

JCI BMS to have the ability to start/stop and provide status on manufacturer 100% OA units. JCI will interact with manufacturer provided BACnet interface in order to provide manufacturer's desired points.

DX Split Systems

JCI BMS to have the ability to start/stop and provide status on manufacturer DX Split Systems. JCI zone t-stat will send signal to DX split system for cooling or heating.

Exhaust Fans

JCI BMS to have the ability to start/stop and provide status on manufacturer exhaust fans.

JCI Control system will have the ability to provide scheduling and night setback.

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PART 1. 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 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 agency, member of Associated Air Balance Council (AABC), approved by Engineer.
 - 1. Work supervised by registered mechanical engineer.
 - 2. Show at least five (5) successfully completed projects of similar size and scope.
- B. Balancing standards: Associated Air Balance Council requirements and recommendations.

1.4 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.

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- 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. 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 the completion of the test and balance services.

1.5 SERVICES OF THE TESTING, ADJUSTING, AND BALANCING FIRM:

- A. 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

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the testing and balancing.

- B. 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.
- C. Prepare and submit to the Architect complete reports covering the balance and operating conditions of each system.
- D. 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.
- E. 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.
- F. 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.
- G. 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.
- H. The air quantities indicated on the Drawings may be varied as required to secure a maximum temperature variation of 3 Deg. F. within each separately controlled space, but the total air quantity indicated for each zone must be obtained. 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.
- I. Before final acceptance is made, the "TAB" firm shall furnish to the Architect the following data:
 - 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 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. Motor current readings at each equipment motor. List the voltages at the time of each reading.
 - 5. The final report shall certify test methods and instrumentation used, final velocity readings obtained, air quantities at each inlet and outlet (supply, return and

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SYSTEM TESTING AND BALANCING**

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.

6. 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.
7. 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.

1.6 INSTRUCTION:

- A. During the test period, the Contractor shall instruct the building operating personnel in the construction and operation of all equipment.

END OF SECTION

**SECTION 16010
GENERAL PROVISIONS FOR ELECTRICAL WORK**

PART 1. GENERAL**1.1 WORK INCLUDED:**

- A. Furnish 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 additional details or special construction as required for work indicated or specified in the division or work specified in other divisions. Furnish and install material and equipment usually furnished with systems or required to complete and make operative the installation, whether specifically mentioned or not.

1.2 GENERAL REQUIREMENTS:

- A. Division 16 Work includes proper routing of raceways, grouping of conductors, wiring and hook-up of devices and equipment in accordance 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. The drawings indicate general locations of devices and equipment, but final locations shall be determined in reference to the Architectural, Structural, Mechanical and Electrical Drawings.
- B. The Architectural, Structural and Mechanical Drawings and Specifications including 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 materials and equipment, shall conform to NFPA 70-1999; the applicable requirements of the utility companies supplying energy, communications and other services to the project; the codes of the City pertaining to electrical installation; and with national, state and local codes and laws relating to construction, building and public safety.
- B. Each of the above regulations is a minimum standard. Where the requirements of these minimum standards conflict with the requirements of the Contract Documents, the more stringent shall be followed.
- C. Obtain permits and arrange for inspections and approval 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 Owner's Representative as a condition of acceptance. Assume and pay fees and other costs involved in obtaining the permits, inspection certificates and approvals as a part of Division 16 Work.

1.4 SHOP DRAWINGS AND OTHER SUBMITTAL:

- A. Shop drawing submittal shall be in a 3-ring binder, organized by specification index. Failure to submit shop drawings in herein-specified format is cause for automatic

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GENERAL PROVISIONS FOR ELECTRICAL WORK**

rejection.

- B. Submit Shop Drawings of fully descriptive catalog data for items of materials and equipment proposed to be furnished and/or installed. Submit number of copies as required in Division 1.
- C. Submit sufficiently early to allow (10) ten working days 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 Submittals by the Owner's Representative 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 Owner's Representative 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 16 Work.

1.5 STANDARDS FOR ELECTRICAL MATERIALS:

- A. Materials shall be new and free from defects and shall conform to the standards of 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 be considered as for approval by the engineer subject to price justification and adherence to substitution provisions herein stated.

1.6 SUBSTITUTIONS:

- A. A substitution request form must be submitted to the Owner's Representative no later than 5 days prior to bid date with working descriptive catalog material, test data, samples, etc, of both the specified material and the proposed substitute, as well as cost justification and 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. Lack of acceptance shall not be basis for change in the work.

1.7 INTERPRETATION OF CONTRACT DOCUMENTS:

- A. Where Drawings or Specifications conflict or are unclear, advise Owner's Representative in writing before Award of Contract. Otherwise, interpretations of Contract Documents by the Owners Representative shall be final. No additional compensations shall be permitted due to discrepancies or inconsistencies in the documents resolved according to the Owner's Representatives interpretation.

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- B. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both.
- C. Should there be conflicts in Contract Documents, provide the greater quantity, the higher quality and the more restrictive of equipment and work.
- D. Electrical Drawings do not limit the Contractor's responsibility of determining full extent of work required by Contract Documents. Refer to Architectural, Civil, Structural, Mechanical, Electrical, and other Drawings. Also refer to divisions of the specifications that indicate types of construction in which the work shall be installed and the work of other trades with which work of this Division must be coordinated.
- E. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.
 - 1. Where Drawings or Specifications do not coincide with manufacturer's recommendations, or with applicable codes and standards, alert Owner's Representative in writing before installation. Otherwise, make changes in installed work, as Owner's Representatives requires within Contract Price.
 - 2. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be a situation in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component. In cases such as this, where the contractor has failed to notify the Owner's Representative of the situation prior to contract award, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.
 - 3. Drawings are generally diagrammatic and indicate the arrangement and approximate location of fixtures, equipment and conduit. When necessary to deviate from the arrangement indicated to meet structural conditions or to clear work of other Divisions, inform the Owner's Representative of proposed deviation before proceeding. Obtain in the field all information relevant to the placing of electrical work.
 - 4. Drawings and Specifications do not undertake to indicate every item required to produce a complete and properly operating installation. Materials, equipment or labor not indicted by which can be reasonably inferred to be necessary for a fully complete, secure and properly installation suitable for the intended use shall be provided.
 - 5. Schematic diagrams shown on the drawings indicate the required functions only. Standard circuits of the particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic drawings shown. Additional wiring or conduit required for such deviations

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shall be furnished at Contractor's expense.

6. Generally, except in the case of empty and underground raceways, the runs of feeder, branch circuits and signal systems raceways are not indicated on the drawings. Final determinations as to the routing shall be governed by structural conditions, and interference with other trades, by terminal locations on apparatus, as approved by the Project Manager.

1.8 COORDINATION OF THE WORK:

- A. The Contractor shall review the drawings of the various trades, verify space requirements and coordinate the sequence of the Work. Any changes required to avoid interference shall be submitted to the Owner's Representative for approval and shall be made as approved without additional cost to the Owner.
- B. The Contractor shall review the Architectural drawings for the location of suitable openings and aisles for the passage of equipment to be installed under this Division. The Contractor shall be responsible for having suitable openings and aisles left open until his equipment has been properly installed.
- C. The Contractor shall review the Architectural drawings for the location of necessary access panels and notify Owner's Representative of any inadequacies prior to closing in of spaces.
- D. Review submittals of equipment furnished under other Divisions prior to installation. Notify Owner's Representative of any deviation before electrical rough in. Verify location, size, and required connections. Coordinate details of equipment connections with supplier and installer.

PART 2. PRODUCTS

2.1 SUPPORTING DEVICE:

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel channel supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.
- D. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angels with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
 1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
 2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps,

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threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps or click-type hangers.

- F. Expansion Anchors: Carbon-steel wedge or sleeve type.
- G. Toggle Bolts: All-steel springhead type.
- H. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 ELECTRICAL IDENTIFICATION:

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.
 - 1. Type: Pretensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.
 - 2. Type: Pre-printed, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.
 - 3. Color: Black letters on orange background.
 - 4. Legend: Indicates voltage.
- C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.
- D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend that indicates type of underground line.
- E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16th-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch thickness for larger sizes. Engraved legend in black letters on white background.
- H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part

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1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.

- I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend and size appropriate to the application. 1/4 –inch grommets in corners for mounting.
- J. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.3 JOINT SEALERS:

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide one of the following or approved equal:
 - a. "Dow Corning Fire Stop Foam," Dow Corning Corp.
 - b. "Pensil 851", General Electric Co.

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. Submittal of bid indicates acceptance of existing conditions.

3.2 SERVICE, CONNECTIONS AND PERMITS:

- A. Obtain permits, inspections, approvals, construction document review and site observations by the authorities having jurisdiction. Obtain certificates of inspection and acceptance and transmit these to the Owner's Representative as a condition of acceptance. Fees and other costs involved in obtaining these permits, inspections and approvals shall be assumed and paid under the Division of the Work.
- B. Arrange for services and pay costs to completely install and place in operation the systems, as indicated in the contract documents.
- C. Temporary Power:

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1. Incidental work necessitated by temporary electrical requirements and temporary electrical work necessary for the temporary for mechanical work shall be included in the electrical bidders proposal, even though not particularly mentioned.
 2. Temporary lighting and power installations shall be provided during the period of construction, remodel, maintenance, repair, demolition, during emergencies or tests. Upon completion of the construction or purpose for which the temporary wiring was installed, temporary installations shall be removed.
 3. Feeders shall originate from an approved power center or distribution board. Conductors shall be protected against overcurrent and fault conditions. Branch circuits shall originate in a code-approved panelboard. Temporary feeders and branch wiring shall be so installed to comply with all applicable codes.
 4. Receptacles shall be of the grounding type and wiring shall contain a separate grounding conductor to which all receptacle ground terminals shall be attached. Receptacles shall be ground fault interrupting. No temporary lighting shall be served by a receptacle.
- D. The contractor shall arrange the work to avoid interruptions of electrical power service to the project. Necessary interruptions shall be granted only during other than normal working hours. Obtain written permission from the Owner's Representative for any interruptions.
- E. Metering:
1. The electrical service shall be as indicated on contract documents.
 2. The Utility Company will make available to the Contractor drawings and standards for any required metering equipment and enclosure for metering. The Contractor shall secure said metering equipment and enclosure together with installation instructions and shall furnish labor, material, and tools to properly install the enclosure as directed by the utility company. Furnish conduit, supports, etc. required for a complete and workable utility approved installation.

3.3 COORDINATION:

- A. Coordinate work with that of other trades and adjacent projects to make proper installation 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. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Install ¼-inch-diameter or larger threaded steel hanger rods, unless otherwise

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indicated.

- D. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

3.4 RECORD DRAWINGS:

- 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 Owner's Representative upon completion and acceptance of the work and before final payment is made.

3.5 OPERATION AND MAINTENANCE DATA:

- A. After completion of the work, the Contractor shall furnish and deliver four (4) copies of a complete manual. Each manual shall include one (1) copy of each approved shop drawing, catalog pages, instruction sheets, operating instructions, installation and maintenance instructions, and spare parts bulletins. Provide separate sections for each electrical system, i.e., power system, lighting system, fire alarm system, etc.
- B. Submit manuals in 3-ring binders, properly indexed and with a Table of Contents.
- C. Furnish these manuals to the Owner's Representative for review and transmission to the Owner.

3.6 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. Use signs, barriers, covers and other means, which clearly indicate the importance of protecting equipment from damage.
- B. After the installation is complete, and before equipment is energized, thoroughly clean the interior and exterior of 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 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.

3.7 PAINTING AND PROTECTION:

- A. Electrical equipment such as disconnect switches, switchboards, panelboard fronts, motor control centers and transformers with marred finishes in transit or during installation shall be refinished under this Division of Work to present an appearance equal to the factory finish.

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- B. Electric work in areas of the construction not scheduled for painting under other Divisions shall have a protective finish under this Division of work. Paint exposed and non-rust inhibited hangers and supports not provided with a factory finish, with two (2) coats of primer and two (2) coats of enamel.

3.8 CUTTING AND PATCHING:

- A. Perform cutting necessary for the installation of Division 16 Work. Cutting shall be carefully and neatly done so as not to damage or cut away more than necessary.
- B. Where Division 16 workmen damage or cut away work, patching will be performed as a part of Division 16 Work. Patching will be by craftsman experienced in performing this type of work.

3.9 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, motor control centers, disconnects, starters, panel boards, and main control cabinets for alarm systems. Typed directories shall be provided.
- 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. Identify raceways and cables with color banding as follows:
 - 1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
 - 3. Colors: As follows:
 - a. Fire Alarm System: Red.
 - b. Security System: Blue and yellow.
 - c. Telecommunication System: Green and yellow.
- D. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- E. Install continuous under plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communications lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed

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GENERAL PROVISIONS FOR ELECTRICAL WORK**

16 inches, overall, use a single line marker.

- F. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
 - 1. Phase A: Black
 - 2. Phase B: Red.
 - 3. Phase C: Blue.
 - 4. Neutral: White.
 - 5. Ground: Green.

- G. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
 - 1. Phase A: Yellow.
 - 2. Phase B: Brown.
 - 3. Phase C: Orange.
 - 4. Neutral: White with a colored stripe or gray.
 - 5. Ground: Green

3.10 ELECTRICAL AND TELEPHONE SERVICE CONNECTIONS:

- A. Provisions for electrical service, installation at service gutter, service feeders, current transformers and metering, and main service switches will be furnished and installed under the appropriate sections.
- B. Conduit for telephone service shall be extended to the main telephone board installed under the base contract and terminated.
- C. Other electrical work illustrated on the accompanying drawings and specified herein shall be included under the base contract.

3.11 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 acceptable results in accordance with the requirements of the Code and these specifications.
- C. Any unacceptable result shall be repaired under this Contract to the satisfaction of the Owner's Representative.
- D. Owner's Representative shall be provided with a written report of tests.

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3.12 GUARANTEE:

- A. Work done, 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.

3.13 TRAINING:

- A. Provide one (1) 8-hour block of training and familiarization of the installation for the owner's selected representative (s).
- B. Provide training and familiarization with equipment as required. Reference other sections of Division 16 for detailed training requirements.

END OF SECTION

**SECTION 16110
RACEWAYS****PART 1. GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install complete systems of raceways for the installation of electrical conductors and other materials 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. Raceways include conduits, ducts, wire ways, gutters, cable trays, fittings, and similar items as indicated in other sections of the work.

1.2 REFERENCE DOCUMENTS:

- A. Specifications:
 - 1. Section 16010 - General Provisions for Electrical Work
 - 2. Section 16130 - Junction and Pull Boxes
 - 3. Section 16134 - Outlet Boxes
 - 4. Section 16190 - Supporting Devices
 - 5. Section 16450 - Grounding

1.3 SUBMITTALS:

- A. Submit complete information including manufacturer, material, and finish on each type of raceway to be installed in accordance with Section 16010 and Division 1.
- B. Submit complete information on methods and materials for support of each type of raceway.
- C. Submit complete information on sealant types.

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. Conduits shall be in accordance with ANSI Standard C 80.
- C. Raceways shall be suitably protected for the installation and each portion of the protective coating that are damaged during receiving, handling and installation shall be refinished to conform to manufacturer recommendations.

PART 2. PRODUCTS**2.1 GENERAL:**

- A. 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

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RACEWAYS**

adjacent enclosure. Interiors shall be accessible through captive screw covers. Supports and interior protection shall be provided for conductors.

2.2 SLEEVES:

- A. Sleeves shall be rigid metal conduit, unless otherwise noted, with a size equal to (2) times the trade diameter of the raceway to pass through the sleeve. Sleeves for conduits through exterior walls shall be PVC coated rigid metal conduit where subject to moisture.
- B. Sleeves for conduits or cables through interior walls shall be electrical metallic tubing. Furnish plastic insulating bushings for cable sleeves at each end.
- C. Sleeves through waterproof walls, floors and roofs shall be provided with water-stop flanges at the point of waterproofing membrane. Stub-up sleeves through floors a minimum of 6 inches above finished floor unless otherwise noted.

2.3 PITCH PANS:

- A. Pitch pans shall be galvanized steel pans of the shape of the raceway passing through the waterproofing membranes, of the size to provide a 1 to 2 inch 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 a minimum of 1 inch above the finished surface.

2.4 SMOKE AND FIRE STOP SEALANT:

- A. Smoke and fire stop sealant caulk shall be in accordance with the UL materials directory and shall meet the fire and smoke rating of the partition.

2.5 RIGID METALLIC CONDUITS AND FITTINGS (RMC):

- A. 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.
- B. Locknuts and bushing shall be galvanized steel except molded canvas bakelite bushings may be used for 2 inch trade size and bakelite insulated, lined steel bushings may be used for conduits two and one-half inches and larger.

2.6 INTERMEDIATE METALLIC CONDUIT (IMC.):

- A. Intermediate metal conduit shall be hot-dipped galvanized steel tubing with galvanized threads.
- B. Fittings and accessories shall be the same as set forth for rigid metallic conduit.

2.7 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS:

- A. Electrical metallic tubing shall be standard galvanized.
- B. Couplings and connectors for EMT shall be steel compression type with steel gland nuts. Connectors shall be uninsulated throat type for power circuits. Cast metal, setscrew or indenture fittings are prohibited.

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RACEWAYS**

- C. Steel compression fittings with insulated throats shall be used for conduits for systems rated 50 volts or less and empty raceway systems.

2.8 FLEXIBLE METAL CONDUIT AND FITTINGS:

- A. Flexible metal conduit shall be spirally wound galvanized steel.
- B. Terminators of flexible metal conduit shall be UL listed for use with the conduit.

2.9 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT AND FITTINGS:

- A. Liquid tight flexible metal conduit shall be spirally wound heavy gauge galvanized steel with an extruded polyvinyl chloride jacket to completely seal the conduit from liquid entry.
- B. UL listed for use with the conduit and have a threaded locking mechanism and factory installed "O" ring seals.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUITS AND FITTINGS:

- A. PVC conduit and fittings shall be UL 651 schedule 40 or schedule 80. They shall be designed for use under ground, shall be non-conductive. 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.
- B. PVC conduit shall meet NEMA TC-2 and be rated for 90-degree centigrade conductors or cable and for use in direct sunlight.
- C. PVC fittings and boxes shall be UL 514B/C.

2.11 SPECIAL FITTINGS:

- A. Split couplings shall be UL listed for the conduit used. Couplings used on metallic conduit shall have an approved bonding jumper.
- B. Expansion fittings shall meet NEMA FB-1 and be UL listed for the conduit used. Fittings used on metallic conduits shall have an approved bonding jumper.
- C. Expansion / deflection fittings shall meet NEMA FB-1 and be UL listed for the conduit used. Fittings used on metallic conduits shall have an approved bonding jumper.

2.12 PULL STRING:

- A. One-eighth inch polypropylene line.

PART 3. EXECUTION**3.1 MATERIAL SELECTION:**

- A. Raceways shall be rigid metal conduit unless otherwise indicated.
- B. Intermediate metal conduit 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.

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- C. Electrical metallic tubing may be used for raceways above furred ceilings, within dry wall partitions, in equipment rooms where not subject to physical damage.
- D. Schedule 40 PVC may be used underground or in areas indicated on drawings.
- E. Wiring connections to motors, transformers, or other devices, which are subject to vibration or require adjustment, shall be flexible metallic conduit. The flexible metal conduit shall not exceed 18 inches in length. Where these connections are outdoors, or in damp locations, or are connections to any kitchen or commercial laundry type equipment, liquid tight flexible conduit shall be used.
- F. Elbows shall be of the same materials as the conduit except for PVC installations. All PVC conduit systems shall have rigid metal elbows unless otherwise noted. Elbows in EMT and small rigid conduits may be job-fabricated with a bender made specifically for the purpose.
- G. 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 one-half inch (1/2)

3.2 CONDUIT:

- A. 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.
- B. 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.
- C. 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.
- D. Place conduits through the roof or exterior walls in time to allow sealing around the raceways as work is installed. Conduits through built up roofs shall run through galvanized pitch pans. Conduits through pitched roofs shall be run through lead flashing.
- E. Recessed lighting fixtures installed in ceiling tile systems shall be having an independent length of flexible conduit extended from an accessible junction box to the fixture. 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.
- F. Cover each end of each conduit with an approved cap or plug as soon as the conduit is installed to prevent entry of foreign material. Conduits shall be dry and clean before wires are pulled.

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- G. 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.
- H. 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. In straight-in-line runs between boxes, cabinets or devices, runs shall not exceed 100 feet.
- I. Conduit installed underground outdoors shall have minimum 24 inches cover.
- J. Conduit service entrance 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.
- K. Non-metallic conduit installed under building slabs shall have minimum 12 inches cover.
- L. Contractor shall carefully coordinate power and branch circuit conduit runs with those conduits required for telecommunications. There shall be a minimum of 18 inches separation between parallel runs, and a minimum of 6 inches separation for perpendicular crossings.
- M. Install a pull string with each end properly marked for use in each conduit installed and in which no conductors are installed under this Division of Work. Secure pull string at each end.
- N. Make conduit joints mechanically tight and electrically continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, etc. Pitch the conduit in areas where moisture may be present to avoid creating moisture traps. Where indicated or necessary to prevent accumulation of water in the conduit, provide a junction box with a drain fitting at the conduit system's low point.
- O. Group the conduit in parallel runs where practical and use a conduit rack constructed of steel channels with conduit straps or clamps. Provide space for an additional 25 percent conduit. Do not install exposed, diagonal conduit runs. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings.
- P. Install escutcheons on exposed conduits passing through interior floors, walls and ceilings. Install fire seals on conduit passing through fire-rated partitions, floors and ceilings.

3.3 FITTINGS:

- A. Install double locknuts and a bushing at each rigid conduit termination except for terminations into threaded hubs.
- B. Coat all threaded connections subject to moisture or underground with cold galvanizing before making connection up.
- C. Furnish threaded grounding bushings for panel and switchgear feeders at each end.

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RACEWAYS**

- D. Furnish insulating bushings on the end of empty conduits stubbed out for future data, telephone, etc.
- 3.4 PROTECTIONS AND CLEANING:**
- A. Raceways shall 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 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.
- 3.5 SLEEVES AND OPENINGS:**
- A. Install rigid metal conduit sleeves with diameters at least 1/2" greater than the outside diameter of the sleeved conduit. Fill the annular space with oakum and the ends of the sleeve with fire-resistant compound. Provide 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.
- B. 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 prevent water passing through the conduit.
- C. Route wire ways, 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.
- D. 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.

END OF SECTION

**SECTION 16114
CABLE TRAY****PART 1. GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install complete systems of cable tray as a part of the raceway system for support of conductors for power and/or audio/visual cables.

1.2 REFERENCE DOCUMENTS:

- A. The General Provisions for electrical work are hereby made a part of this section of the work. Refer to section 16010.
- B. See Section hereinafter for supporting devices.

1.3 SUBMITTALS:

- A. Submit complete manufacturer's specification data on tray sections, fittings, offsets, supports, elbows, tees, etc. proposed to be furnished.
- B. Submit layout drawing plan incorporating the tray within the project including spacing of supports and loading data.

1.4 QUALITY ASSURANCE:

- A. Cable Tray system shall be in accordance with NEMA Standards Publication VE-1 and shall bear the label of the Underwriters Laboratories', Inc. Cable Trays shall be UL classified as equipment grounding conductors.
- B. Each tray length, fitting, offset, etc., shall be UL classified.

PART 2. PRODUCTS**2.1 CABLE TRAY AND FITTINGS:**

- A. Screw or hinged cover as indicated on drawings.
- B. Straight sections, fittings, and side rails shall be extruded from high strength aluminum alloy or galvanized steel. Radiused fittings shall be measured at the center of the tray width.
- C. Trays shall have a minimum usable loading depth of three (4) inches.
- D. Straight Section side rails shall be supplied in lengths of twelve (12) and twenty-four (24) feet. Width as specified on contract documents.
- E. Rail height of fitting and tray shall be equal.
- F. Splice plates shall be of the bolted type using either square neck or ribbed neck carriage bolts and serrated flange lock nuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed .00033 OHMS.
- G. The cable tray shall be designed so that a splice plate located anywhere along the span shall not decrease the strength of the cable tray system.

**SECTION 16114
CABLE TRAY**

- H. The distance between the end of a cable tray section and the cable tray supports shall be no more than a maximum of 25% of the cable tray section.

2.2 LOADING CAPACITIES:

- A. Cable tray shall be capable of carrying a uniform distributed load consistent with Nema VE-1 classifications.

2.3 MATERIALS:

- A. Cable tray shall be as follows unless otherwise specified on contract documents:
1. Ladder type cable tray shall be galvanized steel.
 2. Center hung type cable tray shall be high strength aluminum.
 3. Basket type cable tray shall be high strength steel wire.

PART 3. EXECUTION

- A. Tray shall be trapeze mounted to conform to Nema VE-1 classification or as noted on contract documents.
- B. Run tray concealed from view in finished areas. Run at levels and locations to avoid interference with the structure finished ceilings, walls, and existing lines or ducts. Coordinate tray installation with the owner's representative and the architect to allow available spaces to be used in the most efficient and workmanlike manner.
- C. Route tray parallel with or at right angles to building walls. Install tray out of close proximity to any potentially hot device, steam pipe, hot water pipe, or other heating device. Tray shall not be run within three (3) inches of the exterior insulation of such pipe, device, or duct.
- D. Where tray crosses building expansion joints furnish and install 24AST-1014 expansion plates and 9A-1600 laminated bonding jumper.

END OF SECTION

**SECTION 16115
WIREWAYS**

PART 1. GENERAL

1.1 WORK INCLUDED:

Furnish labor, materials, and equipment necessary to install a complete wire way system.

1.2 RELATED WORK COVERED ELSEWHERE:

General Requirements for Electrical Work	Section 16110
Conduits	Section 16111
Supporting Devices	Section 16190

1.3 SUBMITTALS:

Submittals shall be in accordance with Section 16010 and shall include wire way sections, fittings, and connective devices.

PART 2. PRODUCTS

2.1 MANUFACTURED PRODUCTS:

A. Wire way: Constructed from no less than 16-gage sheet steel. Wire ways shall be complete with end closures, supports, and associated fittings, having the form and dimension suited to the application.

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Provide systems of wire ways of sufficient size as indicated on contract documents.
- B. Where contract documents do not provide wire way dimensions size wire way cross-sectional area and length based upon conductor fill and equipment served as required by NEC and local codes.
- C. Install types based on environmental conditions to which the wire way is exposed. Field applies an undercoating over cuts or scratches before any other finish is applied. Securely ground raceway and fittings. Provide bushings at raceway entrances.

END OF SECTION

**SECTION 16120
WIRE AND CABLE - 600 VOLTS AND UNDER**

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 a complete electrical system.

1.2 REFERENCE DOCUMENTS:

- A. Section 16010 - General Provisions for Electrical Work
- B. Section 16721 – Fire Alarm System

1.3 SUBMITTALS:

- A. Submit complete manufacturers' specification data on each type of conductor to be supplied to the job.
- B. Include cable identification as a part of the submittal.

1.4 QUALITY ASSURANCE:

- A. Electrical conductors shall be UL listed.

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.
- B. Where not specifically indicated below, wire and cable insulation type shall be per Code.
 - 1. General use - Type THHN or THWN, 600 volts.
 - 2. Branch circuits - Type THHN, 600 volts.
 - 3. Control wiring - Type THHN 600 volts.
 - 4. Underground in conduit - Type THHN/THWN, or XHHW 600 volts.
 - 5. Direct buried – Type UF or USE 600 volts.
 - 6. Reference other specification sections for alarm communications and other low-energy systems wiring.

Wire shall be solid for No. 10 and smaller and stranded for No. 8 AWG and larger.

- C. Colors for each phase and neutral shall be used consistently throughout each system. The following color codes shall be used:

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WIRE AND CABLE - 600 VOLTS AND UNDER**

208Y/120 V SYSTEMS
OR 120/240 V SYSTEMS

480Y/277V. SYSTEMS

Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue (Orange high leg)	Yellow
Neutral	White	Gray
Ground	Green	Green
Isolated Ground	Green with Tracer	Green with Tracer
Switch Legs	Yellow with Tracer Phase	

- D. Wire and cable shall be factory color coded except 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 tape or by coating a 3" band of waterproof lacquer. Marking shall be at each end of the cable and at each junction or pull box.

2.2 TERMINATIONS, SPLICES AND TAPS:

- A. Cable terminations, splices and taps for copper conductors shall be UL listed for the intended purpose.
- B. For bus terminations in distribution boards and panel boards, the termination shall be a manufactured compression lug with a NEMA standard bolthole pattern.
- C. Cable splices for cable larger than #6 AWG shall be made using compression but splice lugs.
- D. Cable taps shall be made using manufactured power splice block.

2.3 SUPPORTS:

- A. Supports for wiring in cabinets, panels, pull boxes, wire way and junction boxes shall be nylon cable ties.
- B. Supports in vertical feeders shall be two-piece conduit type or flexible mesh pulling grip type.

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. 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. Where not shown on the drawings, provide the proper number of wires in each conduit to complete the entire electrical system.
- C. Where the conductor size is not indicated on plan, size the conductor per the over current device used up-stream. Refer to NEC Article 310. Ampacity rating shall be based on the temperature rating of the conductor used or the temperature rating of the termination lugs which ever is lower.

SECTION 16120
WIRE AND CABLE - 600 VOLTS AND UNDER

3.2 INSTALLATION:

- A. Route conductors through an approved Electrical Raceway. Install conductors and pull wire into conduit only after conduits and outlet boxes are permanently in place.
- B. Run feeders and mains continuously without splice from load to line terminals and identify phases in each pull box and in the gutters of each switchboard and panel board 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, wire ways, and junction boxes and tie with nylon cable ties. Clamp or fasten control or circuit cabling in cabinets or other equipment with nylon cable clamps and mounting brackets.
- D. Install cable supports per in vertical feeders and in boxes provided for the feeders where not terminated in electrical panels or equipment within code distances.
- E. Provide a wiring color-coding legend at each over current protective device enclosure.

3.3 TERMINATIONS, SPLICES AND TAPS:

- A. Use hydraulic compression tool and manufacturer required die for compression lugs.
- B. Spring connectors may be used for splicing No. 8 AWG or smaller conductors.

3.4 SUPPORTS:

- A. Install supports to hold conductors in place in each panel board, 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 16122
WIRE CONNECTIONS AND DEVICES**

PART 1. GENERAL**1.1 WORK INCLUDED:**

Furnish labor, materials and equipment necessary to install wire connections and devices.

1.2 REFERENCE SECTIONS:

General Requirements for Electrical Work	Section 16010
600-Volt Wires and Cables	Section 16120

1.3 SUBMITTALS:

Submittals shall be in accordance with Section 16010 and Division 1. Submit copies of the manufacturer's specifications and catalog cut sheets for products to be used.

PART 2. PRODUCTS**2.1 MANUFACTURED PRODUCTS:****A. CONNECTOR, COMPRESSION**

For splicing and termination; 600 volt wiring; connectors for cable sized #8 AWG and larger shall be the long barrel type for double indentation. Soldered connections shall not be permitted.

B. CONNECTOR, 600 VOLT TWIST-ON

Spring insulated may be used for #14 through #10 gauge conductors.

C. CONNECTOR, 600 VOLT TERMINAL

Connector shall have two holes in the tongue for use on conductor sizes 250 kcmil or larger; not required for connections to the branch circuit breaker in electrical panels.

D. INSULATION

Insulate any connection made with non-insulated connectors. Provide sufficient amount of tape to equal wire insulation. Half lap each layer. Use UL listed electrical tape.

E. GROUNDING CONNECTION

1. Provide exothermic connection to ground rod and underground connection to the grounding systems.
2. The exothermic welding system furnished under these specifications shall meet the applicable requirements of IEEE-80, Chapter 9.
3. Two styles of exothermic connection shall be available: One primarily for indoor and the other for outdoor application.
 - (a) Exothermic connection to be used outdoors shall be suitable for exposure to the elements or direct burial.

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WIRE CONNECTIONS AND DEVICES**

- (b) Exothermic connection to be made in finished buildings or confined spaces shall use the double filtered, low smoke, low emission, process which is metallurgically equal to the above connection.

- 4. Molds shall be made from material withstanding welding temperatures. The molds shall bear permanent marking, indicating the name of the manufacturer, the mold model, the type and size of welding mixture compatible with the welding process, and the size of the conductor. The installer is prohibited from using a mold from one manufacturer with a different manufacturer's welding mixture.

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Splice 600 Volt conductors in junction boxes or at outlets only. Splices, excluding those made with insulated wire nuts, shall be insulated with electrical tape or heat-shrink tubing to a level equal to the 600-volt rating of the factory insulated conductors. Electrical connections utilizing lugs with threaded set screws and wire sizes of 1/0 AWG and larger shall have an oxide inhibitor applied to prevent oxidation.

- B. Connection to electrically operated equipment is included in this contract, whether or not specifically mentioned.

END OF SECTION

**SECTION 16130
JUNCTION AND PULL BOXES**

PART 1. GENERAL**1.1 WORK INCLUDED:**

- A. Furnish and install junction and pull boxes where indicated or necessary for installation of the wiring systems.
- B. Secure prior approval from the owner's representative for exposed locations of boxes not specifically located on the drawings.

1.2 REFERENCE SECTIONS:

General Requirements for Electrical Work	Section 16010
Supporting Devices	Section 16190

1.3 SUBMITTALS:

Submittals shall be in accordance with Section 16010 and Division 1. Submit copies of the manufacturer's specifications and catalog cut sheets for products to be used.

PART 2. PRODUCTS**2.1 MATERIALS:**

- A. Junction and pull boxes shall be flush or surface type as indicated on the contract documents or as required to fit into the building construction.
- B. Junction and pull boxes installed in walls and ceiling spaces shall be code-gauge-galvanized steel with galvanized steel covers.
- C. Junction and pull boxes installed in floors shall be galvanized malleable cast iron with gasketed covers.
- D. Junction and pull boxes installed outdoors shall be weatherproof with watertight gasketed covers fastened with corrosion resistant screws.
- E. Except as otherwise indicated, boxes shall be not less than code requirements and their size shall be determined as follows:
 - 1. 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.
 - 2. 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

**SECTION 16130
JUNCTION AND PULL BOXES**

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.

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Install junction and pull boxes in a neat workmanlike manner.
- B. Provide auxiliary conductor supports in large boxes per NEC Article 370 where conductors must be supported.

3.2 LABELING:

- A. Conductors passing through boxes containing feeders shall be marked as to phase/voltage and circuit numbers.
- B. Junction boxes for fire alarm, security and public address/communication shall be labeled as such.
- C. Branch circuit junction boxes to be labeled with the panel and circuits(s) designation.
- D. Essential system (life safety, critical and equipment branches) j-boxes shall be painted to match existing color scheme established for the facility.

END OF SECTION

**SECTION 16134
OUTLET BOXES**

- G. Through-the-wall type boxes shall not be used.

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Install and leave boxes in a neat, clean and workman like manner. Set plaster rings to within 1/8" of the finished surface.
- B. Determine exact locations of outlets from the contract documents or at the site by the Owner. Modify outlet locations from those shown on the contract documents to accommodate door swings or to fit other construction details without cost to the Owner.
- C. Unless noted otherwise in the contract documents 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:
1. Wall Switches: 48" and immediately adjacent to strike side of door.
 2. Convenience Receptacles: 18" vertically oriented except 23" for electric water coolers.
 3. Convenience receptacles and telephone outlets above counter: 4" above backsplash or trim, horizontally mounted, when indicated above counter.
 4. Telephone and Data Outlets: 18" vertically oriented except 48" for wall phones.
 5. Wall mounted outlets for audio/visual equipment: 78" AFF.
- D. Where receptacles and telephone/data outlets are shown together, it is intended for them to be grouped as close together as possible. The rough in of all back boxes shall be arranged to minimize horizontal distance between cover plates.
- E. Do not mount boxes on opposite sides of any partition or wall back-to-back. Contractor shall maintain a minimum of 1" clearance horizontally in dry-wall partitions. Contractor shall maintain minimum 4" clearance horizontal for insulated walls.

END OF SECTION

**SECTION 16140
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 in contract documents.

1.2 REFERENCE DOCUMENTS:

- A. The General Provisions for Electrical Work are hereby made a part of this section of the work. Refer to Section 16010.

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 UL and CSA certified, listed NEMA Standard, and suitable for the service required for the intended use of the device in this installation.
- B. Where devices manufactured by Arrow Hart, Bryant, Hubbell, P & S, Leviton, Walker/Wiremold, Thomas & Betts, Square D, 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. Devices shall be Hospital grade and red in color where connected to a critical hospital system.
 - 2. Wall Switches: 20 ampere, 120/277 volt AC, Federal Spec grade.
 - 3. Pilot Lighted Switches: 20 ampere, 120/277 volt AC, Federal Spec grade with red handle (glow when "on").
 - 4. Dimmer Switches: 20 amperes, 120/277 volt AC, Federal Spec grade, slide digital touch type with indicator lights.
 - 5. Convenience Outlets: Duplex receptacles Federal Spec grade 20 ampere, 125 volt 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 or Owner.
 - 6. Isolated Ground Receptacles: NEMA 5-20R. 3 contact Grounded parallel slot contacts. Provide stainless steel cover plate.
 - 7. Ground Fault Circuit Interrupter Convenience Outlets: Side wired 20

**SECTION 16140
WIRING DEVICES**

ampere, 120 volt with appropriate wall plate.

8. Welding and special equipment outlets shall be furnished and installed to match the connecting plugs as provided by the Owner on specialized equipment.
9. Manual Motor Starters: Overload heater sized to the motor nameplate rating.
10. Flush Poke Through Floor Outlets: 20 ampere, 124 volt AC, double duplex power and telephone/data service and fire classification to match floor rating.
11. Flush Floor Box: Cast iron, semi-adjustable, concrete tight for flush assemblies. Box shall have separate compartment for power, telephone, and data. Telephone and data compartments shall have a 1" conduit under floor to above the nearest accessible ceiling space. Box shall have brass cover plates unless noted otherwise.
12. Other receptacles: Other receptacles shall be of type and characteristics and NEMA configuration to provide service as indicated for the special service as required.

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 conduit boxes used with exposed conduit runs. All plates shall be type 302 stainless steel cover plates with matching screws unless otherwise noted.
2. Future or abandoned outlet: Smooth blank cover plates with matching screws.

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Each device shall be suitable for the type of service for which it is installed. 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 plate on 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. All devices connected to a critical Hospital system shall be red.
- D. Wire all devices with proper polarity and suitably ground. Provide green head grounds screw and 6-inch pigtail in boxes. Connect to green wire circuit ground.
- E. Install separate isolated ground from isolated ground receptacles to panel board isolated ground bus. Isolated ground shall not be connected to green wire circuit ground.

**SECTION 16140
WIRING DEVICES**

END OF SECTION

**SECTION 16141
SURFACE METAL RACEWAY****PART 1. GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install surface metal raceways as indicated in the contract documents to provide convenience power outlets, data outlets, telephone outlets and other special system outlets.

1.2 REFERENCE DOCUMENTS:

- A. Specifications
- B. Governing codes as required by the National Electrical Code - Article 352A and 353 and all materials shall be U.L. listed and so labeled.

1.3 ACCEPTABLE MANUFACTURERS:

- A. The following manufacturers are acceptable under this specification:
 - 1. The Wiremold Company, West Hartford, CT

PART 2. PRODUCTS**2.1 MATERIALS:**

- A. Furnish and install, two piece surface metal raceway consisting of base and cover with devices as indicated in contract documents.
- B. Assembly shall include as required any wire caps, support clips, ground clamps, entrance fittings, blank end fittings and necessary devices.
- C. Factory fabricated sections shall be pre-punched steel.
- D. Surface metal raceways may be pre-wired or wired in the field.

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Set in place and plumb raceway bases.
- B. Install fittings, supports, clips, wire straps, end fittings, and conduit entry fittings as required for a complete installation.
- C. Install and make ready for operation devices.

3.2 QUALITY ASSURANCE:

- A. Test power receptacles for continuity and polarity manufactured tester.
- B. Components shall be UL listed.

END OF SECTION

**SECTION 16170
DISCONNECTS****PART 1. GENERAL****1.1 WORK INCLUDED:**

- A. Furnish labor, materials, equipment and incidentals necessary to install disconnects.

1.2 RELATED WORK COVERED ELSEWHERE:

- A. General Requirements for Electrical Work Section 16010
- B. Supporting Devices Section 16190

1.3 QUALITY ASSURANCE:

- A. Acceptable manufacturers shall be firms regularly engaged in the design, manufacturer, and testing of electrical disconnect switches and shall have been producing such products for at least five (5) years.
- B. Comply with NFPA 70 for components and installation.

1.4 SUBMITTALS:

- A. Submittals shall be in accordance with Section 01300, SUBMITTALS and shall include manufacturer's data: Submit manufacturer's specifications and catalog cuts for products to be used, including fuses if fusible disconnect.

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide disconnect switches by one of the following:
 - 1. Fusible Switches:
 - a. General Electric Co.; Electrical Distribution and Control Division.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
 - d. Westinghouse Electric Corp.; Distribution & Control Business Unit.

2.2 DISCONNECT SWITCHES:

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
- C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

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DISCONNECTS**

1. Outdoor Locations: Type 3R.
2. Kitchen Areas - Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: Type 4.

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Install disconnect switches as required by the NEC and local codes. Install fuses in fusible disconnect switches.
- B. Install disconnect switches level and plumb
- C. Connect disconnect switches and components to wiring system and to ground as indicated and instructed by manufacturer.
 1. Tighten Electrical connectors and terminals according to manufacturers published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL486B.

3.2 FIELD QUALITY CONTROL:

- A. Testing: After installing disconnect switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. Correct malfunctioning units on site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 CLEANING:

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

**SECTION 16190
SUPPORTING DEVICES****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 Provisions for Electrical Work are hereby made a part of this Section of the work. Refer to Section 16010.

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 panel boards, cabinets, and 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.

**SECTION 16190
SUPPORTING DEVICES**

- B. Maintain horizontal and vertical alignment of raceways so as not to adversely affect 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, panel boards, 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. All plenum rated cable required to be installed under this contract shall be supported by bridle rings, J-hooks, and/or C/D rings on five (5) foot centers.
- H. Rust inhibits 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 16231
PACKAGED ENGINE GENERATORS**

PART 1. GENERAL**1.1 RELATED DOCUMENTS:**

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

1.2 SUMMARY:

- A. This Section includes packaged diesel-engine generator sets with the following features and accessories:
 - 1. Battery charger
 - 2. Day tank
 - 3. Engine generator set
 - 4. Muffler
 - 5. Exhaust piping external to set
 - 6. Outdoor enclosure
 - 7. Remote annunciator
 - 8. Remote stop switch
 - 9. Starting battery
- B. Related Sections include the following:
 - 1. Division 16 Section "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and stopping signals for engine generator sets.

1.3 DEFINITIONS:

- A. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.
- B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- C. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 SUBMITTALS:

- A. Product data: Include data on features, components, ratings, and performance. Include the following:

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PACKAGED ENGINE GENERATORS**

1. Dimensioned outline plan and elevation drawings of engine generator set and other components specified.
 2. Thermal damage curve for generator.
 3. Time-current characteristic curves for generator protective device.
- B. Shop Drawings: Indicate fabrication details, dimensions, weights, loads, required clearances, and method of field assembly, components, and location and size of each field connection.
1. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 3. Wiring Diagrams: Detail wiring for power and control connections and differentiate between factory-installed and field-installed wiring.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- D. Field Test and Observation Reports: Indicate and interpret test results and inspection records relative to compliance with performance requirements.
- E. Certified summary of prototype-unit test report.
- F. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
- G. Factory Test Reports: For units to be shipped for this Project, showing evidence of compliance with specified requirements.
- H. Sound measurement test report.
- I. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.
- J. Field test report of tests specified in Part 3.
- K. Maintenance Data: For each package engine generator and accessories to include in maintenance manuals specified in Division 1. Include the following:
1. Detail operating instructions for both normal and abnormal conditions.

1.5 QUALITY ASSURANCE:

- A. Manufacturer Qualifications: Maintain a service center capable of emergency maintenance and repairs at the Project with eight hours' maximum response time.
- B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

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PACKAGED ENGINE GENERATORS**

- C. Source Limitations: Obtain packaged engine generator and auxiliary components specified in this Section through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- E. Comply with NFPA 70.
- F. Comply with NFPA 100 requirements for Level 1 emergency power supply system.

1.6 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.7 MAINTENANCE SERVICE:

- A. Maintenance: At Substantial Completion, begin 12 months' full maintenance by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper, starting, load transfer, and running under load. Include routing preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in the manufacture and installation of original equipment.

1.8 EXTRA MATERIALS:

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every ten of each type and rating, but not less than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2. PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Caterpillar, Inc.; Engine Div.
 - 2. Generac Corp.
 - 3. Kohler Co; Generator Division.

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PACKAGED ENGINE GENERATORS**

4. Onan Corp; Industrial Business Group.

2.2 ENGINE GENERATOR SET:

- A. Furnish a coordinated assembly of compatible components.
- B. Output Connection: Three phase, four wire.
- C. Safety Standard: Comply with ASME B15.1.
- D. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of item.
- E. Power Output Rating: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
- F. Skid: Adequate strength and rigidity to maintain alignment of mounted components without depending on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.
- G. Rigging Diagram: Inscribed on a metal plate permanently attached to skid. Diagram indicates location and lifting capacity of each lifting attachment and location of center of gravity.

2.3 GENERATOR-SET PERFORMANCE:

- A. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.
- B. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
- C. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage recovers to remain within the steady-state operating band within three seconds.
- D. Study-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
- E. Steady-State Frequency Stability: When system is operating at any constant load within rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- F. Transient Frequency Performance: Less than 5 percent variation for a 50 percent step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within five seconds.
- G. Output Waveform: At no load, harmonic content measured line or line to neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.

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- H. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, the system will supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to and generator system component.
- I. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 SERVICE CONDITIONS:

- A. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 5 to 40 deg C.
 - 2. Altitude: Sea level to 1000 feet.

2.5 ENGINE:

- A. Comply with NFPA 37.
- B. Fuel: Fuel oil, Grade DF-2.
- C. Rated Engine Speed: 1800 rpm.
- D. Four-cycle Engine with Maximum Piston Speed of 2250 fpm.
- E. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on engine or skid:
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps or siphons or special tools or appliances.
- F. Engine Fuel System: Comply with NFPA 37. System includes the following:
 - 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 - 2. Relief/Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- G. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment.

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2.6 GOVERNOR:

- A. Type: Adjustable isochronous, with speed sensing.

2.7 ENGINE COOLING SYSTEM:

- A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pump.
- B. Radiator: Rated for specified coolant.
 - 1. Radiator Core Tubes: Nonferrous-metal construction other than aluminum.
 - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 100 percent load condition.
 - 3. Fan: Driven by multiple belts from engine shaft.
- C. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
- D. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- E. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - 1. Rating: 50-psig maximum working pressure with 180 deg F coolant, and noncollapsible under vacuum.

2.8 FUEL SUPPLY SYSTEM:

- A. Comply with NFPA 30 and NFPA 37.
- B. Base-Mounted Fuel Oil Tank: Factory-installed and –piped, listed and labeled fuel oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Capacity: Fuel for twelve hours' continuous operation at 100 percent rated power output.
 - 3. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.9 ENGINE EXHAUST SYSTEM:

- A. Muffler: Critical type, sized as recommended by engine manufacturer. Measured sound level at a distance of 10 feet (3 m) from exhaust discharge, is 85 dBA or less.

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- B. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to muffler drain outlet through a petcock.
- C. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.
- D. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.
- E. Exhaust Piping External to Engine: ASTM A 53, Schedule 40, welded, black steel, with welded joints and fittings.

2.10 COMBUSTION-AIR-INTAKE SYSTEM:

- A. Air-intake Silencer: Filter type provides filtration as recommended by engine manufacturer.
 - 1. Sound level emanating from air intake measured at a distance of 25 feet is 54 dBA or less in 1200- to 4800-Hz frequency band and 56dBA or less in 4800- to 10,000-Hz frequency band.

2.11 STARTING SYSTEM:

- A. Description: 12-V electric, with negative ground and including the following items:
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph in "Service Conditions" Article above.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article above to provide specified cranking cycle at least twice without recharging.
 - 5. Battery Cable: Size as required by generator set manufacturer for battery location within generator enclosure. Include required interconnecting conductors/connection accessories.
 - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater is arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article above. Include accessories required to support and fasten batteries in place.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit complies with UL 1236 and includes the following features:

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- a. Operation: Equalizing-charging rate of 10 A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until battery is discharged again.
- b. Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
- c. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.
- e. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either condition closed contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, mounted in generator enclosure.

2.12 CONTROL AND MONITORING:

- A. Functional Description: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic-transfer switches initiate starting and stopping of the generator set. When the mode-selector switch is switched to the on position, the generator set manually starts. The off position of the same switch initiates generator-set shutdown. When the generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gage are grouped on a common control and monitoring panel mounted on the generator set. Mounting method isolates the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: Include those required by NFPA 110 for a Level 1 system, and the following:
 1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).

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5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Generator overload.
- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- E. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Locate audible device and silencing means where indicated.

2.13 GENERATOR OVERCURRENT AND FAULT PROTECTION:

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
 2. Trip Ratings: Matched to generator rating.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and mounting panel.
- B. Ground-Fault Indication: Comply with NFPA 70, Article 700-7 (d). Integrate ground-fault alarm indication with other generator-set alarm indications.

2.14 GENERATOR, EXCITER, AND VOLTAGE REGULATOR:

- A. Comply with NEMA MG 1 and specified performance requirements.
- B. Drive: Generator shaft is directly connected to engine shaft. Exciter is rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction prevents mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

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- F. Excitation used no slip or collector rings, or brushes, and is arranged to sustain generator output under short-circuit conditions as specified.
- G. Enclosure: Dripproof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel provides plus or minus 5 percent adjustment of output-voltage operating band.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.15 ELECTRIC MOTORS:

- A. Comply with Division 15 Section "Motors."

2.16 OUTDOOR GENERATOR-SET ENCLOSURE:

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools. Instruments and control are mounted within enclosure.
- B. Muffler Location: External to enclosure.
- C. Engine Cooling Airflow through Enclosure: Adequate to maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
- D. Louvers: Fixed-engine cooling air inlet and discharge. Louvers prevent entry of rain and snow.
- E. Automatic Dampers: At engine cooling air inlet and discharge. Dampers are closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.17 FINISHES:

- A. Outdoor Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.18 SOURCE QUALITY CONTROL:

- A. Factory Test: Include prototype testing and Project-specific equipment testing (testing of equipment manufactured specifically for this Project).
- B. Prototype Testing: Performed on a separate engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

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1. Tests: Comply with those required for Level 1 energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110.
 2. Generator Test: Comply with IEEE 115.
- C. Project-Specific Equipment Test: Factory test engine generator set and other system components and accessories before shipment. Perform tests at rated load and power factor. Include the following test.
1. Full load run
 2. Maximum power.
 3. Voltage regulation.
 4. Transient and steady-state governing.
 5. Single-step load pickup.
 6. Safety shutdown.
- D. Observation of Factory Tests: Provide 14 days' advance notice of tests and opportunity for observation of test by Owner's representatives.

PART 3. EXECUTION**3.1 EXAMINATION:**

- A. Examine areas, equipment foundations, and conditions, with installer present, for compliance with requirements for installation and other conditions affecting package engine generator performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine roughing-in of cooling system piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

3.2 CONCRETE BASES:

- A. Install concrete bases of dimensions indicated for packaged engine generators, Refer to Division 3 Section "Cast-in-Place Concrete" and Division 16 Section. GENERAL PROVISIONS FOR ELECTRICAL WORK.

3.3 INSTALLATION:

- A. Comply with packaged engine generator manufacturers' written installation and alignment instructions, and with NFPA 110.
- B. Set packaged engine generator set on concrete bases.
 1. Support generator-set mounting feet on rectangular metal blocks and shims or on metal wedges having small taper, at points near foundation bolts to

**SECTION 16231
PACKAGED ENGINE GENERATORS**

provide 3/4- to 1-1/2-inch gap between pump base and foundation for grouting.

2. Adjust metal supports or wedges until generator is level.
- C. Install packaged engine generator to provide access for periodic maintenance, including removal of drivers and accessories.
- D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
 1. Verify that electrical wiring is installed according to manufacturers' submittal and installation requirements in Division 16 Sections. Proceed with equipment startup only after wiring installation is satisfactory.

3.4 CONNECTIONS:

- A. Electrical wiring and connections are specified in Division 16 Sections.
- B. Ground equipment.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 IDENTIFICATION:

- A. Identify system components according to Division 15 Section "Mechanical Identification" and Division 16 Section. GENERAL PROVISIONS FOR ELECTRICAL WORK.

3.6 FIELD QUALITY CONTROL:

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to assist in testing. Report results in writing.
- B. Testing: Perform field quality-control testing under the supervision of the manufacturer's factory-authorized service representative.
- C. Tests: Include the following:
 1. Test recommended by manufacturer.
 2. InterNational Electrical Testing Association Test: Perform each visual and mechanical inspection and electrical and mechanical test stated in NETA ATS for emergency engine generator sets, except omit vibration baseline test. Certify compliance with test parameters for tests performed.
 3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:

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- a. Single-step full-load pickup test.
 4. Battery Test: Measure changing voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform and integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
 5. Battery-Charger Test: Verify specified rates of charge for both equalizing and float-charging conditions.
 6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 7. Voltage and Frequency Transient Stability Test: Use recording oscilloscope to measure voltage and frequency transients for 50 to 100 percent step-load increases and decreases, and verify that performance is as specified.
 8. Harmonic-Content Test: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 - D. Coordinate tests with tests for transfer switches and run them concurrently.
 - E. Retest: Correct deficiencies identified by test and observations and retest until specified requirements are met.
 - F. Report results of test and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - G. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- 3.7 COMMISSIONING:**
- A. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cells voltages.
- 3.8 CLEANING:**
- A. On completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.
- 3.9 DEMONSTRATION:**

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- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators as specified below:
1. Coordinate this training with that for transfer switches.
 2. Train Owner's maintenance personnel on procedures and schedule for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
 4. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 5. Schedule training with Owner with at least seven days' advance notice.
 6. Minimum Instruction Period: Eight hours.

END OF SECTION

**SECTION 16289A
TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)
HIGH PERFORMANCE**

PART 1 – GENERAL**1.1 DESCRIPTION**

- A. The specified unit shall provide effective high energy transient voltage surge suppression, surge current diversion and high frequency noise attenuation in all electrical modes for equipment connected downstream from the facility's meter or load side of the main overcurrent device. The unit shall be connected in parallel with the facility's wiring system.

1.2 RELATED DOCUMENTS AND APPLICABLE STANDARDS

- A. Systems shall be designed, manufactured, tested and installed in accordance with the following applicable documents and standards:
1. Underwriter's Laboratories (UL1449 2nd Edition and UL 1283)
 2. National Electrical Manufacturers Association (NEMA LS1-1992)
 3. ANSI/IEEE (C62.41-1991 and C62.45-1992)
 4. Military Standards (MIL-STD 220A)
 5. National Electric Code (NEC)
 6. Underwriter's Laboratories 248-1

PART 2 – PRODUCTS**2.1 LIFE-CYCLE TESTING**

- A. The product shall be tested (and will show as passed) for repetitive sequential ANSI/IEEE C62.41 Category C3 (20kV/10kA) impulses. Minimum repetitive strikes with less than 10% degradation of clamping voltage shall be as follows for each kA rating of device:

100 kA (per mode) rated product – 11,000 repetitive C3 strikes
150kA (per mode) rated product – 12,000 repetitive C3 strikes
200kA (per mode) rated product - 13,000 repetitive C3 strikes
250kA (per mode) rated product - 14,000 repetitive C3 strikes
300kA (per mode) rated product - 15,000 repetitive C3 strikes

2.2 SINGLE PULSE SURGE TESTING

- A. The maximum single-pulse surge current capacity per mode shall be verified through testing at an independent third party testing facility, and shall be conducted per NEMA Publication no. LS-1-1992, Sections 2.2.9 and 3.9. Testing shall be conducted in each mode of the device (i.e. L-N, L-G, and N-G) and all tested modes shall be from the same test sample. This test shall include all components of the TVSS system, including disconnects (if applicable) and fusing as a completed assembly. Individual component testing, module testing only, or subsystem testing of the TVSS for compliance with this section will not be acceptable. Testing that causes damage to the device, fuse operation, or voltage clamping performance degradation by more than 10% is not acceptable. The Single Pulse Surge Current Capacity shall be as below:

NOTE: Due to current industry limited capabilities, rating above 200kA will be independently tested to 200kA.

100kA per mode

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150kA per mode
200 kA per mode
250 kA per mode
300kA per mode

2.3 FILTERING

- A. The system shall provide a UL 1283 Listed Electromagnetic Interference Filter capable of attenuating noise levels produced by electromagnetic interference and radio frequency interference. The system's filtering characteristics shall be expressed per NEMA LS-1, 1992, Section 2.2.11.

2.4 FUSING

- A. Fuse Component(s) Identification and Surge Rating:
1. The manufacturer shall provide documentation demonstrating the tested surge current rating (8x20usec) of the fuse. The surge rating of the fuse shall be greater than the combined surge current rating of all downstream connected suppression elements.
- B. Suppression Component(s) Identification and Surge Rating:
1. The manufacturer shall provide documentation identifying the suppression element(s) connected in series with fuse element(s) and provide the suppression element's published 8x20usec surge current rating. The rating of the suppression element(s) shall be less than the rating of upstream fusing element(s).
- C. Surge Performance:
1. All fusing shall be required to meet the single pulse surge current testing requirements of Section 2.2 above.
- D. Isolation:
1. The unit shall have each MOV fused and designed to operate only in the event of an MOV failure within the TVSS device.
- E. Fusing Coordination:
1. Units that can't demonstrate MOV-fuse coordination in 2.4.a and 2.4.d are not acceptable.
- F. UL Rating:
1. All fusing shall be 200kAIC UL248 Recognized.

2.5 SUPPRESSED VOLTAGE RATING

- A. The unit shall be UL 1449 2nd Edition Listed and shall be as follows for L-N, L-G, N-G, and L-L, modes inclusive of the disconnected switch:

100kA – 150kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700

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100kA – 150kA rated products/277/480V units: L-N = 900V, L-G=1000, N-G=800, and L-L=1500
200kA – 300kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700
200kA – 300kA rated products/277/480V units: L-N = 800V, L-G=1000, N-G=900, and L-L=1500

2.6 REDUNDANT SUPPRESSION ELEMENTS

- A. The unit shall provide an additional set of parallel connected, individually fused non-MOV elements, internal to the unit, that shall provide backup protection to the primary suppression devices. If subjected to an overvoltage within the parameters in H below, there shall be no failure or degradation of the primary suppression elements.

2.7 OVERVOLTAGE PROTECTION

- A. The unit shall be capable of withstanding temporary overvoltage events that may encountered within the distribution system, without damaging any of the components within the TVSS, especially MOV's and other non-MOV parallel connected elements, in accordance with NEMA LS-1 1992, Section 2.2.6. The unit shall provide overvoltage protection as follows:

100kA – 200kA/mode rated products:	300 cycles @ 170% rated voltage
250kA – 300kA/mode rated products:	3600 cycles @ 170% rated voltage

2.8 IN-FIELD TESTING

- A. The unit shall be equipped with a performance-data extraction protocol allowing unit performance data, including percent of protection remaining, to be transmitted to an internal/external status analyzer.

2.9 ENCLOSURE

- A. Units shall be provided in a NEMA Type 4/12 enclosure.

2.10 INTEGRAL DISCONNECT SWITCH

- A. The unit shall include an integral safety interlocked disconnect located in the unit enclosure with an externally mounted manual operator. The switch shall be rated for 600VAC. If fuses are included with this switch, the fusing shall be capable of conducting a transient equal to the nameplate transient rating of the TVSS without failure or operation.

2.11 ONLINE DIAGNOSTIC MONITORING

- A. Basic Monitoring:
1. This monitoring shall be the default level monitoring provided if no specific monitoring type is shown on the drawings. As a minimum, this monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the TVSS for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable.
- B. Standard Monitoring:

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1. As a minimum, this monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the TVSS for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable. Additionally, the unit shall include an audible alarm with battery backup, a current sensing surge counter, and two sets of Form C contact for remote monitoring.
- C. Advanced Monitoring:
1. As a minimum, this monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the TVSS for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable. Additionally, the unit shall include an audible alarm with battery backup, a current-sensing surge counter, and two sets of Form C contacts for remote monitoring. Additionally, the unit shall include a visual status of suppression protection available, shown in a percentage from 0% to 100%; indication of the number of swells (voltage>110% of nominal); surges (voltage>130% of peak voltage); sags (voltage<90% of nominal); and outages (power interruptions > 1 cycle) the device has encountered.

PART 3 – EXECUTION**3.1 SYSTEM TESTING**

- A. Upon completion of installation, a factory-authorized local service representative shall provide product start-up testing services. The tests shall include:
1. On-Line Testing: Verification that all suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current voltage.
 2. Off-Line Testing: Impulse injection to verify the system tolerance as well as verification of proper facility neutral-to-ground bond. To be compared to factory benchmark test parameters supplied with each individual unit.

3.2 DOCUMENTATION AND REPORTING

- A. A copy of the start-up test results and the factory benchmark testing results shall be supplied to the engineer and the owner for confirmation of proper system function. This letter shall also clarify that the integrity of all neutral-to-ground bonds were verified through testing and visual inspection, and that all grounding bonds were observed to be in place.

3.3 SYSTEM WARRANTY

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- A. The TVSS system manufacturer shall warranty the entire system against defective materials and workmanship for a period of ten (10) years following delivery from the manufacturer.

END OF SECTION

**SECTION 16289B
TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)
LOW PERFORMANCE**

PART 1. GENERAL**1.1 DESCRIPTION**

- A. The specified unit shall provide effective high energy transient voltage surge suppression, surge current diversion and high frequency noise attenuation in all electrical modes for equipment connected downstream from the facility's meter or load side of the main overcurrent device. The unit shall be connected in parallel with the facility's wiring system.

1.2 RELATED DOCUMENTS AND APPLICABLE STANDARDS

- A. Systems shall be designed, manufactured, tested and installed in accordance with the following applicable documents and standards:
1. Underwriters Laboratories (UL1449 2nd Edition and UL 1283)
 2. National Electrical Manufacturers Association (NEMA LS1-1992)
 3. ANSI/IEEE (C62.41-1991 and C62.45-1992)
 4. Military Standards (MIL-STD 220A)
 5. National Electric Code (NEC)
 6. Underwriter's Laboratories 248-1

PART 2. PRODUCTS**2.1 LIFE-CYCLE TESTING**

- A. The product shall be tested (and will show as passed) for repetitive sequential ANSI/IEEE C62.41 Category C3 (20kV/10kA) impulses. Minimum repetitive strikes with less than 10% degradation of clamping voltage shall be as follows for each kA rating of device:

60 kA (per mode) rated product – 3,500 repetitive C3 strikes
80 kA (per mode) rated product – 4,000 repetitive C3 strikes
100 kA (per mode) rated product – 4,500 repetitive C3 strikes
125 kA (per mode) rated product – 5,000 repetitive C3 strikes
150 kA (per mode) rated product – 5,500 repetitive C3 strikes
200 kA (per mode) rated product – 6,500 repetitive C3 strikes
250 kA (per mode) rated product – 7,000 repetitive C3 strikes
300 kA (per mode) rated product – 7,500 repetitive C3 strikes

2.2 SINGLE PULSE SURGE TESTING

- A. The maximum single-pulse surge current capacity per mode shall be verified through testing at an independent third party testing facility, and shall be conducted per NEMA Publication no. LS-1-1992, Sections 2.2.9 and 3.9. Testing shall be conducted in each mode of the device (i.e. L-N, L=G, and N-G) and all tested modes shall be from the same test sample. This test shall include all components of the TVSS system, including disconnects (if applicable) and fusing as a completed

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assembly. Individual component testing, module testing only, or subsystem testing of the TVSS for compliance with this section will not be acceptable. Testing that causes damage to the device, fuse operation, or voltage clamping performance degradation by more than 10% is not acceptable. The Single Pulse Surge Current Capacity shall be as below:

NOTE: Due to current industry limited capabilities, rating above 200kA will be independently tested to 200kA.

60kA per mode
80kA per mode
100kA per mode
125kA per mode
150kA per mode
200kA per mode
250kA per mode
300kA per mode

2.3 FILTERING

- A. The system shall provide a UL 1283 Listed Electromagnetic Interference Filter capable of attenuating noise levels produced by electromagnetic interference and radio frequency interference. The system's filtering characteristics shall be expressed per NEMA LS-1, 1992, Section 2.2.11.

2.4 FUSING

- A. Fuse Component(s) Identification and Surge Rating:
1. The manufacturer shall provide documentation demonstrating the tested surge current rating (8/20usec) of the fuse. The surge rating of the fuse shall be greater than the combined surge current rating of all downstream connected suppression elements.
- B. Suppression Component(s) Identification and Surge Rating:
1. The manufacturer shall provide documentation identifying the suppression element(s) connected in series with fuse element(s) and provide the suppression element's published 8x20usec surge current rating. The rating of the suppression element(s) shall be less than the rating of upstream fusing element(s).
- C. Surge Performance:
1. All fusing shall be required to meet the single pulse surge current testing requirements of Section 2.2 above.
- D. Isolation:
1. The unit shall have each MOV fused and designed to operate only in the event of an MOV failure within the TVSS device.
- E. UL Rating:

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TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)
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1. All fusing shall be 200kAIC UL248 Recognized.
- 2.5 SUPPRESSED VOLTAGE RATING**
- A. The unit shall be UL 1449 2nd Edition Listed and shall be as follows for L-N, L-G, N-G, and L-L, modes inclusive of the disconnected switch:
- 60kA – 80kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700
60kA – 80kA rated products/277/480V units: L-N = 900V, L-G=1000, N-G=90, and L-L=1800
100kA – 150kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700
100kA – 150kA rated products/277/480V units: L-N = 900V, L-G=1000, N-G=800, and L-L=1500
200kA – 300kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700
200kA – 300kA rated products/277/480V units: L-N = 800V, L-G=1000, N-G=800, and L-L=1500
- 2.6 IN-FIELD TESTING**
- A. The unit shall be equipped with a performance-data extraction protocol allowing unit performance data, including percent of protection remaining, to be transmitted to an internal/external status analyzer.
- 2.7 ENCLOSURE**
- A. Units shall be provided in a NEMA Type 4 enclosure.
- 2.8 INTEGRAL DISCONNECT SWITCH**
- A. The unit shall include an integral safety interlocked disconnect located in the unit enclosure with an externally mounted manual operator. The switch shall be rated for 600VAC. If fuses are included with this switch, the fusing shall be capable of conducting a transient equal to the nameplate transient rating of the TVSS without failure or operation.
- 2.9 ONLINE MONITORING**
- A. Basic Monitoring:
1. This monitoring shall be the default level monitoring provided if no specific monitoring type is shown on the drawings. As a minimum, this monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the TVSS for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable.
- B. Standard Monitoring:
1. As a minimum, this monitoring shall include one set of status lights that will provide visual indication of voltage present to the TVSS for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable. Additionally, the unit shall include an audible alarm

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TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)
LOW PERFORMANCE**

with battery backup, a current-sensing surge counter, and two sets of Form C contacts for remote monitoring.

- C. Advanced Monitoring:
1. As a minimum, this monitoring shall include one set of status lights that will provide visual indication of voltage present to the TVSS for each phase of protection. The lights shall also indicate when suppressor protection has degraded to any value of less than 50%. Status indicator lights that simply indicate the presence of voltage, and provide no indication of performance, will be unacceptable. Additionally, the unit shall include an audible alarm with battery backup, a current-sensing surge counter, and two sets of Form C contacts for remote monitoring. Additionally, the unit shall include a visual status of suppression protection available, shown in a percentage from 0% to 100%; indication of the number of swells (voltage > 110% of nominal); surges (voltage > 130% of peak voltage); sags (voltage < 90% of nominal); and outages (power interruptions > 1 cycle) the device has encountered.

PART 3. EXECUTION

3.1 SYSTEM TESTING: Upon completion of installation, a factory-authorized local service representative shall provide product start-up testing services. The tests shall include:

- A. On-Line Testing: verification that all suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current and voltage.
- B. Off-Line Testing: Impulse injection to verify the system tolerances as well as verification of proper facility-to-ground bond. To be compared to factory benchmark test parameters supplied with each individual unit.

3.2 DOCUMENTATION AND REPORTING:

- A. A copy of start-up test results and the factory benchmark testing results shall be supplied to the engineer and the Owner for confirmation of proper system function. This letter shall also clarify that the integrity of all neutral-to-ground bonds were verified through testing and visual inspection, and that all grounding bonds were observed to be in place.

3.3 SYSTEM WARRANTY:

- A. The TVSS system manufacturer shall warranty the entire system against defective materials and workmanship for a period of (10) ten years following delivery from the manufacturer.

3.4 MANUFACTURERS:

- A. Current Technology Transguard or approved equal Liebert Interceptor II.

END OF SECTION

**SECTION 16410
UNDERGROUND SERVICES**

PART 1. GENERAL**1.1 WORK INCLUDED:**

- A. Furnish and install a complete system of wiring in conduit from the utility company pad mounted transformer to the C.T. Cabinet.
- B. Furnish and install a complete system of empty conduit for telephone and cable TV as required.

1.2 REFERENCE DOCUMENTS:

- A. The General provisions for electrical work are hereby made a part of this section of the work. Refer to Section 16010.
- B. Specification Section 16111 and Section 16120 are hereby made a part of this Section of work.

1.3 SUBMITTALS:

- A. Submit as built record drawings locating underground conduits by location and depth with reference to the building and the property lines.

PART 2. EXECUTION**2.1 INSTALLATION:**

- A. Electrical Contractor to obtain from each utility company specific detailed instructions, sketches, drawings and documents illustrating the application of their services to the project.
- B. All necessary excavation and backfill shall be accomplished by each Trade under their phase of the work. All such work shall be included regardless of the type of materials encountered in excavation.
- C. All trenches shall be excavated to the required depths for proper slope of pipes. The depth of cover shall be as specified herein after. Trenches shall be not less than 12" wider than the outside diameter of the raceways to be laid therein. The bottoms of the trenches shall be tamped hard and graded to secure maximum fall.

Should rock be encountered, it shall be excavated to a depth of 6" below the bottom of the raceways and shall be backfilled to the proper grade with pea gravel thoroughly tamped. Raceways laid in trenches dug in fill shall be supported down to load bearing, undisturbed soil. After the raceways have been tested, inspected and approved by the inspecting authorities, the trenches shall be backfilled.

- D. The trenches shall be carefully backfilled with pea gravel to a depth of 6" above the top of the raceway. The next layer and subsequent layers of backfill may be excavated materials if of earth, loam, sand or gravel free of large clods and with no rocks larger than 1-1/2" in diameter. Backfill shall be installed in layers 12" deep, adequately tamped and wetted down or flushed before the second layer of earth is laid in place. This additional material required for backfilling shall be furnished and any excess material required for backfilling shall be furnished and any excess material and debris shall be removed from the site. Any special backfill material shall be provided as hereinafter specified or shown on the drawings.
- E. All excavating and backfilling shall be done in a manner so as not to disturb adjacent

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UNDERGROUND SERVICES**

structures and shoring required shall be furnished and installed.

- F. Trenches for raceways inside the building shall be properly excavated, following in general the procedures set up for exterior raceways. Where floors are to be poured, trenches shall be backfilled, tamped and settled with water. Where no flooring is to be installed, trenches shall be backfilled to form a level grade.
- G. All surplus materials removed in these trenching operations shall be properly disposed of.
- H. Service laterals shall be installed with not less than thirty-six inches (36") minimum cover, and concrete encased under driveways, parking lots, and other areas subject to vehicular traffic.
- I. Underground raceways shall be installed within a separate excavation from gas, sewer, and water lines. Electrical raceways may share the same trench providing twelve-inch (12") separation is maintained between power and telephone.
- J. Schedule 40 PVC raceway is approved for underground services however, rigid steel galvanized sleeves shall be provided where raceways cross under roadways or driveways. Minimum raceway cover beneath roadways and driveways shall be thirty-six inches. (36").
- K. Conductors for power shall run continuous without weld, splice, or joint from the utility transformer secondary bushings to the utility metering cabinet adjacent to the electrical room.
- L. At raceway termination at the telephone board furnish and install a conduit sealing bushing sized to the cable to prevent entrance of moisture. OZ Type CSB or equal.
- M. At service termination at the transformer secondary furnish and install suitable connectors sized to the cable.
- N. Underground installation shall be in accordance with Article 300-5 National Electrical Code.
- O. Not less than eight feet of coiled conductor shall be furnished at the transformer bushing for termination by the Utility Company. The Electrical Contractor shall furnish the cable connectors for each conductor per Utility Company Standards.

PART 3. INSPECTION AND TEST

- A. Prior to backfilling operations, the underground installation shall be inspected and approved by the local inspection authority and by the utility company affected.
- B. Electrical Contractor shall secure a certificate of satisfactory acceptance from the utility.
- C. Backfill in accordance with provisions as herein above specified.

END OF SECTION

**SECTION 16415
TRANSFER SWITCHES****PART 1. GENERAL****1.1 RELATED DOCUMENTS:**

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

1.2 SUMMARY:

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switch
 - 2. Remote annunciation and control system.

1.3 SUBMITTALS:

- A. Product Data: Include ratings and dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- B. Wiring Diagrams: Detail wiring for transfer switches and differentiate between manufacturer-installed and field-installed wiring. Show both power and control wiring.
- C. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for load ratings and short-circuit closing and withstand ratings applicable to units for Project.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- E. Field Test Reports: Indicate and interpret test and inspection results for compliance with performance requirements.
- F. Maintenance Data: For each type of product to include in maintenance manuals specified in Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE:

- A. Manufacturer Qualifications: Maintain a service center capable of providing emergency maintenance and repairs at Project site with an eight-hour maximum response time.
- B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies (Level 3 or higher), to supervise on-site testing specified in Part 3.

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TRANSFER SWITCHES**

- C. Source Limitations: Obtain automatic transfer switch, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction.
- E. Comply with NEMA ICS 1.
- F. Comply with NFPA 70.
- G. Comply with NFPA 110.
- H. Comply with UL 1008, unless requirements of these Specifications are stricter.

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Conventional Transfer Switches:
 - a. Caterpillar, Inc.; Engine Division.
 - b. Emerson Electric Co.; Automatic Switch Co. Subsidiary.
 - c. Kohler Co.
 - d. Onan Corp.; Electrical Products Division.
 - e. Russelectric, Inc.
 - f. ASCO

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS:

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Testing Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
- C. Annunciation, Control, and programming Interface Components: Devices at transfer switches for communication with remote programming devices, annunciators, or annunciator and control panels have communications capability matched with remote device.
- D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

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TRANSFER SWITCHES**

- E. Resistance to Damage by Voltage Transients: Components meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components meet or exceed voltage-impulse withstand test NEMA ICS 1.
- F. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- G. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6; UL 508, unless otherwise indicated.
- H. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
 - 1. Designed Terminals: Pressure type suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- J. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver Composition or silver allow for load-current switching. Conventional automatic transfer-switch units rated 225 A and greater have separate arcing contacts.

2.3 AUTOMATIC TRANSFER SWITCHES:

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is the same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. Digital Communications Interface: Matched to capability of remote annunciator or annunciator and control panel.

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- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled, unless both sources are live.

2.4 AUTOMATIC TRANSFER-SWITCH FEATURES:

- A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
- B. Time delay for override of normal-source voltage sensing delays and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
- C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
- D. Time Delay for Retransfer to Normal source: Adjustable from 0 to 30 minutes; factory set for 10 minutes. Provide automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
- E. Test Switch: Simulates normal-source failure.
- F. Switch-Position Pilot Lights: Indicate source to which load is connected.
- G. Source-Available Indicating Lights: Supervise sources via transfer-switch, normal- and emergency-source sensing circuits.
 - 1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - 3. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
- H. Unassigned Auxiliary Contacts: Two normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
- I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicated override status.

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- J. Engine Starting Contacts: One isolated, normally closed and one isolated, normally open, rated 10 A at 32-V dc minimum.
- K. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes; factory set for five minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.
- L. Engine-Generator Exercise: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - 1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - 2. Push-button programming control with digital display of settings.
 - 3. Integral battery operation of time switch when normal control power is not available.

2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM:

- A. Functional Description: Include the following functions for indicated transfer switches:
 - 1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - 2. Indication of switch position.
 - 3. Indication of switch in test mode.
 - 4. Indication of failure of digital communications link.
 - 5. Key-switch or user-code access to control functions of panel.
 - 6. Control of switch-test initiation.
 - 7. Control of switch operation in either direction.
 - 8. Control of time-delay bypass for transfer to normal source.
- B. Malfunction of annunciator, annunciation and control panel, or communications link shall not affect functions of automatic transfer switch. In the event of failure of the communications link, automatic transfer switch automatically reverts to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
 - 1. Controls and indicating lights grouped together for each transfer switch.

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TRANSFER SWITCHES**

2. Label each indicating light control group. Indicate the transfer switch it controls, location of the switch, and the load it serves.
3. Digital Communications Capability: Matched to that of transfer switches supervised.
4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

2.6 FINISHES:

- A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.7 SOURCE QUALITY CONTROL:

- A. Factory Test Components, Assembled Switches, and Associated Equipment: Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test comply with NEMA ICS 1.

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- B. Identify components according to Division 16 Section GENERAL PROVISIONS FOR ELECTRICAL WORK.

3.2 WIRING TO REMOTE COMPONENTS:

- A. Match type and number of cables and conductors to control and communications requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 CONNECTIONS:

- A. Ground equipment as indicated and as required by NFPA 70.

3.4 FIELD QUALITY CONTROL:

- A. Testing: Test transfer-switch products by operating them in all modes. Perform tests recommended by manufacturer under the supervision of manufacturer's factory-authorized service representative. Correct deficiencies and report results in writing. Record adjustable relay settings.
- B. Testing: Perform the following field quality-control testing under the supervision of the manufacturer's factory-authorized service representative in addition to tests recommended by the manufacturer:
 1. Before energizing equipment, after transfer-switch products have been installed:

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- a. Measure insulation resistance phase-to phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Meet manufacturer's specified minimum resistance.
 - b. Check for electrical continuity of circuits and for short circuits.
 - c. Inspect for physical damage; proper installation and connection; and integrity of barriers, covers, and safety features.
 - d. Verify that manual transfer warnings are properly placed.
 - e. Perform manual transfer operation.
2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown sequence.
- C. Coordinate tests with tests of generator plant and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.5 CLEANING:

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.6 DEMONSTRATION:

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TRANSFER SWITCHES**

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain transfer switches and related equipment as specified below:
1. Coordinate this training with that for generator equipment.
 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
 4. Schedule training with Owner, with at least seven days' advance notice.
 5. Provide a minimum of four hours of instruction.

END OF SECTION

**SECTION 16440
SWITCHBOARDS****PART 1. GENERAL****1.1 SECTION INCLUDES:**

- A. Main Switchboard - Furnish and install the Service Entrance switchboard(s) as herein specified and shown on the associated electrical drawings.
- B. Distribution Switchboard - Furnish and install the Distribution Switchboard(s) as herein specified and shown on the associated electrical drawings.

1.2 RELATED SECTIONS:

- A. Drawings and General Provisions of the contract, including general and supplementary conditions and Division 1 Specification Sections, apply to this section.

1.3 REFERENCES:

The switchboard(s) and overcurrent protection devices referenced herein are designed and manufactured according to the following appropriate specifications.

- A. ANSI/NFPA 70 - National Electrical Code (NEC).
- B. NEMA AB 1 _ Molded Case Circuit Breakers and Molded Case Switches.
- C. NEMA KS 1 - Enclosed Switches.
- D. NEMA PB 2 - Dead front Distribution Switchboards, File E8681
- E. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Dead front Switchboards Rated 600 Volts or less.
- F. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.

1.4 SUBMITTALS:

- A. Shop Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; wiring diagrams; one-line diagrams showing main and branch current ratings and short circuit ratings; equipment schedule; and switchboard instrument details.

1.5 QUALIFICATIONS:

- A. Listing and labeling: Provide switchboard assemblies specified in this section that are listed and labeled as defined in the national Electrical Code Article 100.
- B. Furnish products listed by Underwriters Laboratories Incorporated and in accordance with standards listed in Article 1.3 - References.
- C. The manufacturing facility shall be registered by Underwriters Laboratories inc. to the International Organization for Standardization ISO 9002 series Standards for quality.

**SECTION 16440
SWITCHBOARDS****1.6 DELIVERY, STORAGE, AND HANDLING:**

- A. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.
- B. Inspect and report concealed damage to carrier within their required time period.
- C. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 PROJECT CONDITIONS:

- A. Verify dimensions by field measurements.
- B. Determine suitable path for moving switchboard into place considering project condition.

1.8 MAINTENANCE MATERIALS:

- A. Provide one (1) set of installation and maintenance instructions with each switchboard. Instructions are to be easily identified and affixed within the incoming or main section of the line-up.

1.9 WARRANTY:

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or eighteen (18) months from date of purchase.

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Shall be Square D Company, Siemens, G.E.
- B. Substitutions must be submitted in writing three (5) days prior to original bid date with supporting documentation demonstrating that the alternate manufacturer conforms to all aspects of the specifications herein.

2.2 MANUFACTURED UNITS:

- A. Front-Connected, Front-Accessible Switchboard: Fixed or Panel-mounted main device as required, panel-mounted branches, and sections rear aligned.
 - 1. Main Device 2000 amps or larger: Individually fixed mounted.

**SECTION 16440
SWITCHBOARDS**

2. Main Device less than 2000 amps: Panel mounted.
3. Branch Devices: Panel mounted.
- B. Ratings: Provide nominal system voltage, continuous main-bus amperage, and short-circuit current ratings as indicated.
- C. Nominal System Voltage: 480/277V, 60 Hz.
- D. Main-Bus Continuous: As indicated.

2.3 FABRICATION AND FEATURES:

- A. Enclosure: Steel; NEMA 250, Type 1, Indoor.
- B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust inhibiting primer on treated metal surface.
- C. Barriers: Between adjacent switchboard sections.
- D. Insulation and isolation for main and vertical buses of feeder sections.
- E. Bus Transition and Incoming Line Pull Sections: Matched and aligned with basic switchboard.
- F. Hinged Front Panels: Allow access to breaker, and blank compartments.
- G. Buses and Connections: 3 phase, 4 wire, except as otherwise indicated. Features as follows:
 1. Phase and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 2. Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
 3. Ground Bus: ¼ by 2 inch minimum size, drawn temper copper of 98 percent conductivity; equipped with pressure connectors for feeder and branch circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 4. Contact Surfaces of Buses: Silver plated.
 5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from both ends.
 6. Isolation Barrier Access Provisions: Permit checking bus bolt tightness.
 7. Neutral Buses: 100 percent of the ampacity of the phase buses, except as indicated, and equipped with approved pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus is braced.

**SECTION 16440
SWITCHBOARDS****2.4 OVERCURRENT PROTECTIVE DEVICES:**

- A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, handle lockable:
 - 1. Characteristics: Ampere ratings below 2000 amps, frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - 2. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
 - 3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
 - 4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
 - 5. Lugs: Mechanical lugs and power-distribution connectors for number, size and material of conductors indicated.
 - 6. Shunt Trip: Where indicated.
- B. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased power circuit breaker:
 - 1. Characteristics: 2000 amperes and larger, frame size, trip rating, number of poles and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - 2. Features: Include the following:
 - a. 2-step stored-energy closing
 - b. Microprocessor-based trip units with interchangeable rating plug and selectable I-squared-t response.
 - c. LED trip indicators
 - d. Remote trip indication and control
 - e. Undervoltage trip
 - 3. Control Voltage: 125 V, ac.
 - 4. Lugs: Mechanical lugs and power-distribution connectors for number, size and material of conductors indicated.
- C. Future Devices: Where indicated, equip compartments with mounting brackets, supports, bus connections, and appurtenances designed for overcurrent protective device types and ampere ratings indicated.

**SECTION 16440
SWITCHBOARDS****2.5 INSTRUMENTATION:**

- A. Multifunction Digital Metering Monitor: Microprocessor-based unit suitable for 3- or 4-wire systems and with the following features:
 - 1. Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, 3 Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, 3 Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.6 CONTROL POWER:

- A. Control Circuits: 120 V, supplied through secondary disconnect devices from control power transformer.
- B. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, complete with bundling, lacing and protection. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 IDENTIFICATION:

- A. Nameplates and label products are specified in Division 16 Section "Basic Electrical Materials and Methods".
- B. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which applied. Produce a concise visual presentation of principal switchboard components and connections.

**SECTION 16440
SWITCHBOARDS**

1. Medium: Painted graphics in approved color contrasting with equipment factory-finish background to represent bus and components, complete with lettered designations.

PART 3 EXECUTION**3.1 INSPECTION:**

- A. Examine area to receive switchboard to provide adequate clearance for switchboard installation.
- B. Check that concrete pads are level and free of irregularities.
- C. Start work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION:

- A. Install switchboard in accordance with manufacturer's written guidelines, NEMA PB2.1, the NEC, and local codes.
- B. Support switchboards on concrete housekeeping bases, 4-inch nominal thickness.

3.3 FIELD QUALITY CONTROL:

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.
- C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- D. Provide the services of a qualified independent testing agency to perform specified acceptance testing.
- E. Test ground fault systems by operating push-to-test button.

3.4 ADJUSTING:

- A. Adjust all operating mechanisms for free mechanical movement per manufacturer's specifications.
- B. Adjust circuit breaker trip and time delay settings to values [indicated.] [as instructed by the Architect/engineer.]

3.5 CLEANING:

- A. Touch up scratched or marred surfaces to match original finish

END OF SECTION

**SECTION 16441
METERING****PART 1. GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install meter base and associated conduit and supports for utility company metering.

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 16010 and Section 16410.
- B. Utility company standards.

PART 2. PRODUCTS

- A. Metering will be accomplished through metering equipment furnished and installed by the Utility Company in accordance with the latest standards for electric service as published by the Utility Company.

PART 3. EXECUTION**3.1 GENERAL:**

- A. The Utility Company will make available to the 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.
- B. 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.
- C. The building panel boards may be utilized for temporary construction power once the local Utility Company establishes metering.
- D. At the end of the construction period, all equipment shall be restored for permanent building use.

END OF SECTION

**SECTION 16450
GROUNDING****PART 1. GENERAL****1.1 SCOPE OF WORK:**

- A. Furnish labor, materials, equipment and incidentals necessary to install a complete grounding system. Work and shall include the following systems:
 - 1. Power system grounding.
 - 2. Communication system grounding.
 - 3. Electrical equipment and raceway grounding and bonding.

1.2 RELATED SECTIONS:

- A. Section 16010 - Basic Electrical Requirements
- B. Section 16120 – Wire and Cable
- C. Section 16670 - Lightning Protection Systems

1.3 SUBMITTALS:

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for grounding rods, connectors and connection materials, and grounding fittings.
- C. Qualification data for firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- D. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

1.4 QUALITY ASSURANCE:

- A. Testing Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7, or full member company of the InterNational Electrical Testing Association (NETA).
 - 1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute of Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Comply with NFPA 70.
- C. Comply with UL 467.
- D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

**SECTION 16450
GROUNDING**

1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Apache Grounding: Nashville Wire Products.
 2. Boggs; H.L. Boggs & Co.
 3. Chance: A.B. Chance Co.
 4. Erico Inc.; Electrical Products Group.
 5. Ideal Industries, Inc.
 6. Kearney.
 7. O-Z/Gedney Co.
 8. Raco, Inc.
 9. Thomas & Betts, Electrical.

2.2 GROUNDING AND BONDING PRODUCTS:

- A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS:

- A. Comply with Division 16 Section “Wires and Cables.” Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including insulation.
- B. Equipment Grounding Conductors: Insulated with green color insulation.
- C. Grounding-Electrode conductors: Stranded cable.
- D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- E. Bare Copper Conductors: conform to the following:
 1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.

**SECTION 16450
GROUNDING****2.4 MISCELLANEOUS CONDUCTORS:**

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.5 CONNECTOR PRODUCTS:

- A. Pressure Connectors: High-conductivity-plated units.
- B. Bolted Clamps: Heavy-duty type.
- C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6 GROUNDING ELECTRODES AND TEST WELLS:

- A. Grounding Rods: Copper-clad steel.
 - 1. Size: $\frac{3}{4}$ inch by 120 inches.
- B. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 inches thick, size as indicated.
- C. Test Wells: Fabricate from 15-inch long, square-cut sections of 8-inch diameter, Schedule 80, PVC pipe.

PART 3. EXECUTION**3.1 APPLICATION:**

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
 - 1. Install equipment grounding conductor with circuit conductors of the items below in addition to the required by Code:
 - a. Feeders and branch circuits.
 - b. Single-phase motor or appliance branch circuits.
 - c. Three-phase motor or appliance branch circuits.
 - d. Flexible raceway runs.
 - e. Armored and metal-clad cable runs.

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2. Computer Outlet Circuits: Install separate equipment grounding conductor in branch circuit runs from computer area power panels or power-distribution units.
 3. Isolated Grounding-Receptacle Circuits: Install a separate insulated equipment-grounding conductor connected to the receptacle-grounding terminal. Isolate grounding conductor from raceway and from panel board grounding terminals. Terminate at the equipment grounding-conductor terminal of the applicable derived system or service, except as otherwise indicated.
 4. Nonmetallic Raceways: Install an equipment-grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
 5. Air-Duct Equipment Circuits: Install an equipment-grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.
 6. Water Heater, Heat-Tracing, and Antifrost Heater Circuits; Install a separate equipment-grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communications systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ¼-by-2-by-12-inch grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Paragraph 250-26.
- D. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductor in compliance with NEPA780.
- E. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.

3.2 INSTALLATION:

- A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- B. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.

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GROUNDING**

1. Drive until tops are 2 inches below finished floor final grade, except as otherwise indicated.
 2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
- C. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches below grade.
- E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- H. Test Wells: One for each driven grounding electrode, except as otherwise indicated. Set top of well flush with finished grade or floor. Fill with 1-inch-maximum-size crushed stone or gravel.
- I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC Paragraph 250-50 (c), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. Where base of concrete foundations is less than 20 feet in length, coil excess conductor within base of concrete foundation. Bond grounding conductor to reinforcing steel to at least 4 locations, and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.3 CONNECTIONS:

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metal to metal direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

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4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturers written instructions. Welds that are puffed up or that show convex surfaces indications improper cleaning are not acceptable.
- C. Equipment Grounding-Wire Terminations: for No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted-and clamped-type connections between conductors and grounding rods.
- F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- H. Moisture Protection: Where insulated grounding conductors are connected to grounding rods of grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING:

- A. Manholes and Handholes: Install a driven grounding rod close to wall and set rod depth so 4 inches will extend above finished floor. Where necessary, install grounding rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from grounding rod into manhole through a waterproof sleeve in manhole wall. Protect grounding rods passing through concrete floor with a double wrapping of pressure sensitive tape or heat shrunk insulating sleeve from 2 inches above to 6 inches below concrete.
- B. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor. Make connections with minimum No. 4 AWG stranded, hard drawn copper wire. Train conductors plumb or level around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and terminations kits.

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GROUNDING**

- C. Grounding System: Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.
- 3.5 FIELD QUALITY CONTROL:**
- A. Independent Testing Agency: Engage an independent electrical testing organization to perform tests described below.
- B. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81.
- C. Maximum grounding to resistance values are as follows:
1. Equipment Rated 500 kVA and less: 10 ohms.
 2. Equipment Rated 500 to 1000 kVA: 5 ohms.
 3. Equipment Rated More than 1000 kVA: 3 ohms.
 4. Pad-Mounted Equipment: 5 ohms.
 5. Manhole Ground: 10 ohms.
- D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.
- E. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

END OF SECTION

**SECTION 16460
INDOOR DRY TYPE TRANSFORMERS**

PART 1. GENERAL**1.1 WORK INCLUDED:**

- A. Furnish and install indoor dry type transformers as indicated on the Drawings.

1.2 REFERENCE DOCUMENTS:

- A. The General Provisions for electrical work are hereby made a part of this section of the work. Refer to Section 16010.
- B. NFPA 70
- C. NEMA ST20 Dry Type Transformers
- ID. EEE C2
- E. IEEE C57.12.01 Dry Type Transformers 1KVA and larger.

1.3 SUBMITTALS:

- A. Submit complete manufacturer's specification data on each type of transformer, including temperature rise, sound level and taps.
- B. Submit a complete description and listing of support devices proposed for each installation.
- C. Submit complete manufacturer's specification data on each transformer proposed for installation including dimensioned plans and wiring diagrams.

1.4 QUALITY ASSURANCE:

- A. Transformers shall be listed by Underwriter's Laboratories, Inc., for the service to be performed and shall bear the UL label. Insulating materials shall be in accordance with NEMA ST20-1972 standard for a 220 Deg. C UL component recognized insulation system. Transformers shall meet NEMA and National Electrical Code enclosure standards and comply with AIEE and ANSI.

PART 2. PRODUCTS:**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide transformers by one of the following:
 - 1. Challenger Electrical Equipment Corp.
 - 2. GE Electrical Distribution & Control
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Groupe Schneider.

**SECTION 16460
INDOOR DRY TYPE TRANSFORMERS**

2.2 TRANSFORMERS, GENERAL:

- A. Description: Factory-assembled and –tested, air-cooled units of types specified, designed for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous copper windings without splices, except for taps.
- D. Internal Coil Connections: Brazed or pressure type.
- E. Enclosure: Class complies with NEMA 250 for the environment in which installed.
- F. Low-Sound-Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS:

- A. Comply with NEMA ST 20 and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Windings: One coil per phase in primary and secondary.
- D. Enclosure: Indoor, ventilated, drip proof.
- E. Insulation Class: 185 or 220 deg C class for transformers 15 kVA or smaller; 220 deg C class for transformers larger than 15 kVA.
 - 1. Rated Temperature Rise: 115 deg C maximum rise above 40 deg C.
- F. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:
 - 1. Taps, 15 through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
 - 2. Taps, 750 kVA and Above: Four 2.5 percent taps, 2 above and 2 below rated high voltage.

2.4 CONTROL AND SIGNAL TRANSFORMERS:

- A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.
- B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.
- C. Description: Self-cooled, 2 windings.

2.5 FINISHES:

- A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

**SECTION 16460
INDOOR DRY TYPE TRANSFORMERS**

- B. Outdoor Units: Comply with ANSI C57.12.18.

2.6 SOURCE QUALITY CONTROL:

- A. Factory Tests: Design and routine tests comply with referenced standards.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project if specified sound levels are below standard ratings.

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Comply with safety requirements of IEEE C2.
- B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.
- C. Identify transformers and install warning signs according to Division 16, Section “General Provisions for Electrical Work”.
- D. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 GROUNDING:

- A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.
- B. Comply with Division 16 Section “Grounding” for materials and installation requirements.

3.3 FIELD QUALITY CONTROL:

- A. Testing Agency: Engage a qualified independent testing agency to perform field quality control testing.
- B. Test Objectives: To ensure transformer is operational within industry and manufacturer’s tolerances, is installed according to the Contract Documents, and is suitable for energizing.
- C. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed “Satisfactory Test” label to tested component.
- D. Schedule tests and provide notification at least 7 days in advance of test commencement.
- E. Report: Submit a written report of observations and tests. Report defective materials and installation.
- F. Tests: Include the following minimum inspections and tests according to manufacturers written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.

**SECTION 16460
INDOOR DRY TYPE TRANSFORMERS**

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage and deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.
 - a. Minimum Test Voltage: 1000V, dc..
 - b. Minimum Insulation Resistance: 500 megohms.
 - c. Duration of Each Test: 10 minutes.
 - d. Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.
- G. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING:

- A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING:

- A. After installing and cleaning, touch up scratches and mars on finish to match original finish.
- B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in readjusting transformer tap settings to actual occupied conditions. Provide up to 2 visits to project site for this purpose without additional cost.
 1. Voltage Recordings: Contractor performed. Provide up to 48 hours of recording on the low-voltage system of each medium-voltage transformer.
 2. Point of Measurement: Make voltage recordings at load outlets selected by Owner.

END OF SECTION

**SECTION 16470
PANELBOARDS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS:**

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

1.2 SUMMARY:

- A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 16 Section GENERAL PROVISIONS FOR ELECTRICAL WORK for general materials and installation methods.

1.3 SUBMITTALS:

- A. Product Data: For each type of panelboard, accessory item, and component specified.
- B. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage ratings. Including the following:
 - 1. Enclosure type with details for types other than NEMA 250, Type 1.
 - 2. Bus configuration and current rating.
 - 3. Short-circuit current rating of panelboard.
 - 4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
 - 5. Wiring Diagram: Details of schematic diagram including control wiring and differentiating between manufacturer-installed and field-installed wiring.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- D. Field Test Reports: Indicate/interpret test results for compliance with performance requirements.
- E. Panelboard Schedules: For installation in panel boards. Submit final versions after load balancing.
- F. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 1. Include manufacturer's written instructions for testing circuit breakers.

1.4 QUALITY ASSURANCE:

- A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control," an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the InterNational Electrical Testing Association.

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PANELBOARDS**

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 1. The terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
- C. Comply with NFPA 70.
- D. Comply with NEMA PB 1.

1.5 EXTRA MATERIALS:

- A. Keys: 6 spares of each type for panelboard cabinet lock.

PART 2 – PRODUCTS**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
 2. General Electric Co.; Electrical Distribution & Control Div.
 3. Siemens Energy & Automation, Inc.
 4. Square D Co.

2.2 PANELBOARD FABRICATION:

- A. Enclosures: Flush- of surface-mounted cabinets as indicated. NEMA PB 1, Type 1 unless otherwise indicated to meet environmental conditions at installed location.
 1. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
- B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.
- C. Directory Frame: Metal, mounted inside each panelboard door.
- D. Bus: Hard drawn copper of 98 percent conductivity.
- E. Main and Neutral Lugs: Compression type.
- F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

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PANELBOARDS**

- G. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.
- H. Special Features: Include the following features for panelboards as indicated:
 - 1. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors, insulated from box.
 - 2. Computer Grade Panelboards: Provide with 2X-sized neutral for K13 type loads.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS:

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

2.4 DISTRIBUTION PANELBOARDS:

- A. Doors: In panelboard front, unless otherwise indicated. Secure door with vault-type latch with tumbler lock, all keyed alike.
- B. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.

2.5 OVERCURRENT PROTECTIVE DEVICES:

- A. Molded-Case Circuit Breaker: NEMA AM 1, handle lockable.
 - 1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - 2. Application Listing: Appropriate for application, including, Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
 - 4. Circuit Breakers, 400 A and larger: Field-adjustable short-time and continuous current settings.
 - 5. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
 - 6. Shunt Trip: Where indicated.

PART 3 – EXECUTION**3.1 INSTALLATION:**

- A. Install panelboards and accessory items according to NEMA PB 1.1.

**SECTION 16470
PANELBOARDS**

- B. Mounting Heights: Top of trim 74 inches) above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.
- E. Install filler plates in unused spaces.
- F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space designated to be ceiling space in the future.
- G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION:

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section GENERAL PROVISIONS FOR ELECTRICAL WORK.
- B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

3.3 GROUNDING:

- A. Make equipment grounding connections for panelboards as indicated.
- B. Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS:

- A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL:

- A. Prepare for acceptance tests as follows:
 - 1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
 - 2. Make continuity test of each circuit.
- B. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing.
- C. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

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PANELBOARDS**

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
- D. Balancing Loads: After substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
1. Perform measurements during period of normal working load as advised by Owner.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.
- E. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of each panelboard. Remove fronts and connections accessible to a portable scanner.
1. Follow-up infrared Scanning: Perform an additional follow-up infrared scanning of each panelboard 11 months after date of Substantial Completion.
 2. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
 3. Record of Infrared Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING:

- A. Set field-adjustable circuit-breaker trip ranges as directed by Engineer.

3.7 CLEANING:

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION

**SECTION 16474
OVERCURRENT PROTECTIVE DEVICES**

PART 1. GENERAL**1.1 RELATED DOCUMENTS:**

- A. Requirements of the following Division 16 sections apply to this Section:
 - 1. General Provisions for Electrical Work
 - 2. Fuses

1.2 SUMMARY:

- A. This Section includes overcurrent protective devices (OCPDs) rated 600 V and below and switching devices commonly used with them.
- B. Panelboards and Switchboards: Application, installation, and other related requirements for overcurrent protective device installation in distribution equipment are specified in other Division 16 sections.

1.3 DEFINITIONS:

- A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.
- B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.4 SUBMITTALS:

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for switches, circuit breakers and accessories, specified in this Section, including descriptive data and time-current for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

1.5 QUALITY ASSURANCE:

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

**SECTION 16474
OVERCURRENT PROTECTIVE DEVICES**

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide fuses by one of the following or approved equal:
1. Molded-Case Circuit Breakers:
 - a. General Electric Co.
 - b. Siemens-ITE Co.
 - c. Square D Co.
 - d. Westinghouse Electric Corp.
 2. Combination Circuit Breaker and Ground Fault Trip:
 - a. Electrical Distribution and Control; General Electric Co.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
 - d. Westinghouse Electric Corp.
- B. Once a selection has been made, that manufacturer's product shall be required throughout.

2.2 OVERCURRENT PROTECTIVE DEVICES (OCPDS), GENERAL:

- A. General: Provide OCPDs in indicated types, as integral components of panelboards and also as individually enclosed and mounted single units.
- B. General: Provide OCPDs in indicated types, as integral components of panelboards and switchboards; and also as individually enclosed and mounted single units.
- C. Enclosures: NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum).
- D. Ratings: Systems shall be fully rated: Series ratings shall not be incorporated to meet short-circuit requirements.

2.3 FUSES:

- A. Fuses are specified in Section 16476.

2.4 MOLDED-CASE CIRCUIT BREAKERS:

- A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."

**SECTION 16474
OVERCURRENT PROTECTIVE DEVICES**

- B. Construction: Bolt-on type, except breakers 225-ampere frame size and larger may be plug-in type if held in place by positive locking device requiring mechanical release for removal.
- C. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating of 10,000 amperes symmetrical for 208/120 volt system and 14,000 amperes symmetrical for 280/277 volt system, unless a greater rating is indicated.
- D. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole.
- E. Combination Circuit Breakers and Ground Fault Circuit Interrupters: UI 943 "Ground Fault Circuit Interrupters," arranged for sensing and tripping for ground fault current in addition to overcurrent and short-circuit current. Provide features as follows:
 - 1. Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.
 - 2. Trip Setting for Ground Fault: 4 to 6 milliamperes, listed and labeled as a Class A, Type 1 device.

2.5 ENCLOSED CIRCUIT BREAKERS:

- A. Enclosed Molded-Case circuit Breaker: NEMA AB-1, handle lockable with two (2) padlocks.
- B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated; interrupting capacity rating to meet available fault current, 10,000 symmetrical rms amperes minimum; with appropriate application listing when used for switching fluorescent lighting loads or heating, air conditioning, and refrigeration equipment.
- C. Interchangeable Trips: Circuit breakers, 200 amperes and larger, trip units interchangeable within frame size. Settings.
- D. Field-Adjustable Trips: Circuit breakers, 400 amperes and larger, with adjustable short time and continuous current settings.
- E. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.
- F. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

2.6 OCPD ACCESSORIES:

- A. Shunt-Trip Devices for Circuit Breakers: Where indicated, arrange to trip breaker from an external source of power through a control switch or relay contacts. Voltage shall be 120 volts, 60 Hz.

**SECTION 16474
OVERCURRENT PROTECTIVE DEVICES**

PART 3. EXECUTION**3.1 INSTALLATION:**

- A. OCPDs in distribution equipment shall be factory installed.
- B. Install enclosed switches and enclosed circuit breakers in locations as indicated, according to manufacturer's written instructions.
- C. Install enclosed switches and enclosed circuit breakers level and plumb.

3.2 IDENTIFICATION:

- A. Identify components in accordance with Division 16 Section General Provisions for Electrical Work.

3.3 CONTROL WIRING INSTALLATION:

- A. Install wiring between OCPDs and control/indication devices as specified in Division 16 Section "Wires and Cables" for hard wired connections.

3.4 CONNECTIONS:

- A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL and UL 486B.

3.5 GROUNDING:

- A. Provide equipment grounding connections for individually mounted OCPD units as indicated or as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL:

- A. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.
- B. Pretesting: Upon completing installation of the system, perform the following preparations for test:
 - 1. Make insulation resistance tests of OCPD buses, components, and supply, feeder, and control circuits.
 - 2. Make continuity tests of circuits.
- C. Visual and mechanical inspection: Include the following inspections and relation work.

**SECTION 16474
OVERCURRENT PROTECTIVE DEVICES**

1. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters.
 2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
 3. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 4. Check tightness of electrical connections of OCPDs with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 5. Clean OCPDs using manufacturer's approved methods and materials.
 6. Verify installation of proper fuse types and ratings in fusible OCPDs.
- D, Retest: Correct deficiencies identified by tests and observations. Verify by the system tests that specified requirements are met.

3.7 CLEANING:

- A. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 DEMONSTRATION:

- A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPDs and train Owner's maintenance personnel.
- B. Conduct a minimum of one half day of training in operation and maintenance as specified in Division 1 Section "Project Closeout" of these specifications. Include both classroom training and hands-on equipment operation and maintenance procedures. Schedule a minimum of 4 hours training.
- C. Schedule training with at least seven days' advance notification.

3.8 COMMISSIONING:

- A. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform and infrared scan of OCPDs including their line and load connections, fuses, and fuse clips. Also scan OCPD contact structures where accessible to a portable scanner. Include individual OCPDs and those installed in switchboards, panelboards, and motor control centers.
- B. Instrument: Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibrations.
- C. Record of Infrared Scanning: Prepare a certified report identifying all OCPDs checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and rescanning observations after remedial action.

END OF SECTION

**SECTION 16476
FUSES****PART 1. GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install all fuses in each device furnished under Division 16 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 SUMMARY:

- A. This Section includes the following:
 - 1. Fuses.
 - 2. Spare fuse cabinet.

1.3 SUBMITTALS:

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Section.
- B. Product Data for each fuse type specified. Include the following:
 - 1. Descriptive data and time-current curves.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Coordination charts and tables and related data.
 - 4. Fuse size for elevator feeder and disconnect applications.
- C. Field test reports indicating and interpreting test results.
- D. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE:

- A. Source Limitations: Obtain fuses from one source and by a single manufacturer.
- B. Comply with NFPA 70 for components and installation.
- C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.5 EXTRA MATERIALS:

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

**SECTION 16476
FUSES**

1. Spare Fuses: Furnish quantity equal to 20 percent of each fuse type and size installed, but not less than 1 set of 3 of each type and size.

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide fuses by one of the following:
 1. Cooper Industries, Inc.; Bussmann Div.
 2. General Electric Co.; Wiring Devices Div.
 3. Gould Shawmut.

2.2 CARTRIDGE FUSES:

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET:

- A. Cabinet: Wall-mounted, 0.05-inch-thick steel unit with full-length, recessed piano-hinged door with key-coded cam lock and pull.
 1. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: Stencil legend "SPARE FUSES" in 1-1/2-inch (40-mm) letters on door.
 4. Fuse Pullers: For each size fuse.

PART 3. EXECUTION**3.1 EXAMINATION:**

- A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS:

- A. Motor Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION:

- A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

**SECTION 16476
FUSES**

- B. Install spare fuse cabinet where indicated.

3.4 IDENTIFICATION:

- A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION

**SECTION 16481
MOTOR CONTROLLERS****PART 1. GENERAL****1.1 WORK INCLUDED:**

- A. Furnish and install wiring necessary to completely connect motor controller devices. This includes HVAC equipment, plumbing equipment, fire protection, and similar items that are installed by other trades.

1.2 REFERENCE DOCUMENTS:

- A. Specifications:
 - 1. Section 16010 – General Provisions for Electrical Work
 - 2. Section 16110 – Raceways
 - 3. Section 16120 – Wire and Cable

1.3 SUBMITTALS:

- A. Submittals shall be in accordance with Division 1 and shall include manufacturer's specifications, catalog cuts, and wiring diagrams for products to be used.
- B. Load – Current and Overload – Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full load currents.

PART 2. PRODUCTS**2.1 MATERIALS: (When provided under Division 16)**

- A. Motor controllers:
 - 1. Shall be 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.
 - 2. Controller shall be equipped with an overload in each ungrounded conductor selected on the nameplate full load current of the motor installed.
 - 3. 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 starters shall have fused switch disconnects. Manual starters shall be used for small single phase motors and shall be toggle switch type, trip free, with overload element.
 - 4. Magnetic starter units 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

**SECTION 16481
MOTOR CONTROLLERS****PART 3. EXECUTION****3.1 INSTALLATION:**

- A. Install independently mounted motor-control devices according to manufacturer's written instructions.
- B. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.
- C. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Division 16 Section "Supporting Devices".
- D. Install freestanding equipment on concrete housekeeping bases.
- E. Motor-Controller Fuses: Install indicated fuses in each fusible switch.

3.2 IDENTIFICATION:

- A. Identify motor-control components and control wiring according to Division 16 Section "General Provisions For Electrical Work."

3.3 CONTROL WIRING INSTALLATION:

- A. Install wiring between motor-control devices according to Division 16 Section "Wires and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic control devices where available.
 - 1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
 - 2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 CONNECTIONS:

- A. Tighten connectors, terminals, bus joint, and mountings. Tighten field-connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B

3.5 FIELD QUALITY CONTROL:

- A. Testing: after installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with

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MOTOR CONTROLLERS**

test parameters.

2. Remove and replace malfunctioning units with new units, and retest.

3.6 CLEANING:

- A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean device internally, using methods and materials recommended by manufacturer.

END OF SECTION

**SECTION 16501
LIGHTING FIXTURES**

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.

1.2 REFERENCE DOCUMENTS:

- A. Specifications:
 - 1. Section 16010 – General Provisions for Electrical Work.
 - 2. Section 16120 – Wire and Cable 600 volts and under.
- B. Other Standards:
 - 1. ANSI C82.11
 - 2. ANSI C62.41
 - 3. FCC Part 18
 - 4. NFPA-70 (National Electrical Code)

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, submits photographs, laboratory test data, photometrics, and option/quality matrix comparing products 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.

1.4 QUALITY ASSURANCE:

- A. Each lighting fixture shall bear the Underwriters' Label indicating the fixture is suitable for the application and installation location.

PART 2. PRODUCTS

2.1 APPROVED MANUFACTURERS:

- A. Inclusion in the Acceptable Manufacturer's list does not indicate pre-approval of specific manufacturer's products. Vendors must comply with this specification and be able to show compliance with the intent of application, photometrics, and quality of the fixtures listed in the fixture schedule.
- B. The lighting fixtures shall be as noted on drawings and as manufactured by one of the following manufacturers or their affiliated companies:

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LIGHTING FIXTURES**

1. Cooper Lighting
2. Lithonia
3. Lightolier

2.2 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. Recessed incandescent fixtures for ceilings that have insulation shall be Type IC.
- D. Surface mounted fluorescent fixtures shall have spacers to achieve required separation from low density ceilings construction.

2.3 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. Incandescent lamps shall be general service inside frosted type except as listed for specific application.
- C. Fluorescent lamps shall be 3500K with a minimum CRI of 82 unless otherwise noted 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.

2.4 BALLASTS:

- A. Unless otherwise noted, all ballasts shall be electronic, High Power Factor, with less than 10% total harmonic distortion.
- B. Each lighting fixture shall be equipped with a 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, Sylvania, GE, Jefferson, or Universal.
- C. 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.
- D. Electronic fluorescent ballasts shall be by physically interchangeable with a standard core/coil electromagnetic ballast or shall be specifically designed and constructed to operate T8 fluorescent lamps or compact fluorescent lamps as scheduled on the plans.

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LIGHTING FIXTURES**

1. Electronic ballast leads shall be color coded to ANSI Standard C82.11 (latest version).
 2. Electronic ballasts shall be designed to support a sustained short to ground or open circuit of any output leads without damage to the ballast.
 3. Case temperatures shall not exceed temperatures set forth in ANSI C82.11.
 4. Ballasts shall operate at both 50 Hz and 60 Hz frequencies.
 5. Electronic ballasts shall meet:
 - a. Requirements of Federal Communication Commission Rules and Regulations Part 18.
 - b. ANSI C82.11.
 - c. ANSI C62.41 CRT A for harmonic distortion.
 - d. Shall contain no PCBs.
- E. Dimming Ballasts for fluorescent lamps shall also meet the following>
1. Minimum dimming range of lumen output with no visible flicker.

<u>LAMP</u>	<u>RANGE</u>
T-8	100% - 1%
T-5	100% - 5%
T-4	100% - 10%
PLT	100% - 20%
 2. Total harmonic distortion < 15%.
 3. Lamp current crest factor < 1.7.
 4. Power Factor > 0.95.
 5. Ballast defaults to full on upon loss of control signal.
- F. Other Gaseous discharge lamp ballasts shall be high power factor constant wattage type. Ballasts for interior mounted fixtures shall be fully 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.

2.5 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.
- B. Recessed fixtures shall be provided with required plaster frames.

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LIGHTING FIXTURES**

- C. Provide concrete inserts, gaskets, sight shields and similar accessory components required for the particular installations in this project.
- D. 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 furnished with integral test indicator and 90-minute illumination capability. Units for fluorescent lamps shall have minimum of 1100 Lumen output.
- E. Lenses for 2x2 and 2x4 lensed troffers shall be 0.125" Prismatic Acrylic unless otherwise noted.

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. Above-ceiling insulation materials are prohibited to be within 3" of recessed lighting fixtures, unless fixture is IC rated.
- 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. Ensure that mounting devices are concealed.
- E. 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 specifically permitted by the construction specified in other Divisions of Work.
- F. Pole Mounted fixtures shall be true and plumb.

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.

**SECTION 16501
LIGHTING FIXTURES**

- B. Lamps used in dimming circuits shall be burned in at full brightness for 100 hours prior to dimming operation.
- C. 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.
- D. Replace lamps that fail or have blackened ends during the period of touch-up.
- E. Metal halide lamps shall be burned in for 100 hours continuously prior to switching operations.

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, and misalignment.
- B. Exterior lights with adjustable mountings shall be adjusted under the direction of the owner's representative at night no earlier than 30 minutes after sunset.

3.4 ATTIC STOCK:

- A. Provide unused lamps to Owner for future replacements as follows:

<u>LAMP</u>	<u>QUANTITY</u>
Incandescent (each type/size)	10%, Minimum 5, no Maximum
Fluorescent (each type/size)	10%, Minimum 1 case, Maximum 2 cases
Metal Halide (each type/size)	10%, Minimum 1, Maximum 1 case
Mercury Vapor (each type/size)	10%, Minimum 1, Maximum 1 case

3.5 SUPPORT:

- A. Support lay in type fixtures independently from the ceiling support system.
- B. Other fixtures shall be securely attached to the structure in accordance with building codes and manufacturer's instructions.

END OF SECTION

**SECTION 16603
EMPTY RACEWAY SYSTEMS**

PART 1. GENERAL**1.1 WORK INCLUDED:**

- A. Furnish and install complete systems of raceways, outlets, junction boxes, terminal boards, cabinets, interconnections, grounding and pull ropes in inaccessible construction for future installation of wires and cables under other sections of work, other divisions of work, other Contractors or Vendors, or by the Owner. See the drawings or other sections of work for and descriptions of the systems.
- B. This work includes provisions for systems such as closed circuit television and telephones where the installation of the system is outside the scope of this Contract.

1.2 REFERENCE DOCUMENTS:

- A. The Special Provisions for Electrical Work are hereby made a part of this Section of the Work. Refer to Section 16010.
- B. The raceway systems shall be in accordance with materials and methods described in 16100 Sections of Work.

1.3 SUBMITTALS:

- A. Submit complete manufacturer's specification data on each type of material to be used.
- B. Submit complete information on raceway routing and tagging to enable others to utilize the raceways in the proper sequence of the work.

PART 2. PRODUCTS**2.1 RACEWAYS:**

- A. Raceways, including wireways, conduits, junction boxes, pull boxes, cabinets, terminal boards and outlets shall be as set forth elsewhere in this specification.

2.2 PULL ROPE:

- A. Pull ropes shall be 3/16" Jet Line Poly rope or equal.

2.3 TAGS:

- A. Tags for identification of termination of raceway shall be 1" x 3" linen paper tages with eyelets and string ties or equal.

PART 3. EXECUTION**3.1 RACEWAYS:**

- A. Raceways including wireways, conduits, junction boxes, pull boxes, cabinets terminal boards and outlets shall be installed asset forth elsewhere in this specification.

**SECTION 16603
EMPTY RACEWAY SYSTEMS**

3.2 PULL ROPE:

- A. Install a pull rope in each conduit installed in this Division of Work, which does not have wire and cable, installed under this Division of Work. Leave 18" of pull rope at each end of each termination.
- B. Coil the pull rope inside of each outlet box cabinet or pull box where raceways are terminated in this equipment. Tie the pull rope at each end terminated otherwise to avoid accidental removal of the pull rope.

3.3 TAGGING:

- A. Provide a line tag on each end of each pull rope installed in this section of work. Securely attach this tag to the pull rope.
- B. Label this tag with a description of the raceway system being provided and with a complete description of the other end of the pull rope.

END OF SECTION

**SECTION 16670
LIGHTNING PROTECTION**

PART 1. GENERAL**1.1 WORK INCLUDED:**

- A. Furnish labor, materials, equipment and incidentals necessary to install a complete lightning protection system in accordance with UL 96A, NFPA 780, and this specification.

1.2 RELATED WORK COVERED ELSEWHERE:

General Requirements for Electrical Work: Section 16010
Grounding: Section 16450

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is NRTL listed or who is certified by LPI as a Master Installer/Designer.
- B. Listing and Labeling: As defined in NFPA 780, Article 2-2, "Definitions."
- C. Provide UL Master Label
- D. Provide LPI certification of system
- E. Provide ETL Master Label indicating system complies with specified requirements.

1.4 SUBMITTALS:

Submittals shall be in accordance with Division 1, and shall include:

- A. Field inspection reports indicating compliance with specified requirements.
- B. Product data for each component specified.
- C. Shop drawings showing type, size and location of all equipment, grounds, cable routings, etc.
- D. Certification of Adequacy of Design.
- E. Certification of Applicator/Subcontractor.
- F. Operational and Maintenance Manuals.

PART 2. PRODUCTS**2.1 MANUFACTURERS:**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A-C Lightning Security, Inc.
 - 2. Harger Lightning Protection, Inc.
 - 3. Heary Bros. Lightning Protection Co., Inc.

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LIGHTNING PROTECTION**

4. Independent Protection Company, Inc.
5. Robbins Lightning, Incorporated
6. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS:

- A. Comply with UL 96.
- B. System Materials: Copper except as noted otherwise.
- C. Roof-Mounting Air Terminals: NFPA Class I, aluminum, solid, unless otherwise indicated.
 1. Single-Membrane, Roof-Mounting Air Terminals: Designed for single-membrane roof materials.
- D. Stack-Mounting Air Terminals: Stainless steel.
- E. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 16 Section "Grounding and Bonding" and standards referenced in this Section.

PART 3. EXECUTION

3.1 INSTALLATION:

- A. Install lightning protection components and systems according to UL 96A, LPI-175, and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- C. Conceal the following conductors.
 1. Systems conductors
 2. Down conductors
 3. Interior conductors
 4. Conductors within normal view from exterior locations at grade within 200 feet (60 m) of building.
- D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components except those above single-ply membrane roofing.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturers written instructions.
- F. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.
- G. A counterpoise installation based on requirements in Division 16 Section "Grounding

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LIGHTNING PROTECTION**

and Bonding” may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum in NFPA 780.

1. Bond ground terminals to counterpoise conductor.
 2. Bond grounded metal bodies on building within 12 feet (3.6 m) of ground to counterpoise conductor.
 3. Bond grounded metal bodies on building within 12 feet (3.6 m) of roof to interconnecting loop at eave level or above.
- H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18 m) intervals.

3.2 CORROSION PROTECTION:

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL:

- A. Periodic Inspections: Engage and LPI inspector to perform periodic inspections during construction and at its completion, according to LPI-177.
- B. UL Inspection: Apply for inspection by UL as required to obtain a UL Master Label for system.
- C. ETL Inspection: Engage an ETL inspector to inspect completed system for compliance with specified requirements.

END OF SECTION

**SECTION 16721
MULTI-FIRE ALARM SYSTEM**

PART 1. GENERAL**1.1 RELATED DOCUMENTS:**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 16 Sections apply to this Section:
 - 1. “Basic Electrical Requirements”.
 - 2. “Basic Electrical Materials and Methods”.
- C. The complete installation is to conform to the applicable sections of NFPA 72 and the National Electrical Code with particular attention to Article 760.
- D. The entire installed system and all integrated system operations shall be within guidelines of the BOCA Basic Building Code.
- E. NFPA 90A
- F. NFPA 101- Life Safety Code
- G. ADA
- H. ASME/ANSI A17.1 and A17.3
- I. NFPA 13
- J. Local ordinances, laws and codes

1.2 SUMMARY:

- A. Work covered by this specification section includes the furnishing of labor, equipment, materials, and complete operational performance required for installation of the Fire Alarm System as shown on the drawings, as specified, and as directed by the Architect/Engineer.
- B. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire Alarm and Detection Operations
 - 2. All Smoke Control Related Fan System, Door Hold-open devices, Fire Suppression Appliances, Remote Monitoring of Sprinkler, and /or Off Premise Notification.
 - 3. Built-in approved digital communicator with UL required priority reporting.
- C. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 15 Section “Fire Protection” for water-flow, pressure, or tamper switches connected to fire alarm system.

**SECTION 16721
MULTI-FIRE ALARM SYSTEM**

2. Division 15 Section “Electric Control Systems” for duct smoke detectors.

1.3 DEFINITIONS:

- A. Air Sampling-Type Detector: A detector that consists of a piping or tubing distribution network from the detector to the area(s) to be protected. An aspiration fan in the detector housing draws air from the protected area back to the detector through air sampling ports, piping, or tubing. At the detector, air is analyzed for fire products.
- B. Alarm: A warning of fire danger.
- C. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of a manual station, smoke detector, heat detector, flame detector, or sprinkler water-flow switch.
- D. Alphanumeric Display: The visual representation of output data other than printed copy. Displays plain-language description of alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
- E. Annunciator: A unit containing two or more indicator lamps, alpha-numeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location.
- F. Automatic Extinguishing System Supervision: Devices that respond to abnormal conditions that could affect the proper operation of an automatic sprinkler system or other fire extinguishing system, including but not limited to control valves; pressure levels; liquid agent levels and temperatures; pump power and running, engine temperature and over-speed; and room temperature.
- G. Automatic Fire Detectors: Fire is a phenomenon that occurs when a substance reaches critical temperature and reacts chemically with oxygen (for example) to produce heat, flame, light, smoke, water vapor, carbon monoxide, carbon dioxide, or other product and effects. An automatic fire detector is a device designed to detect the presence of fire and initiate action. For the purpose of this definition, automatic fire detectors are classified as listed below.
 1. Heat Detector: A device that detects abnormally high temperature or rate-of-rise.
 2. Smoke Detector: A device that detects visible or invisible particles of combustion.
- H. Central Station: A supervising station that is listed for central station service.
- I. Circuit Interface: A circuit component that interfaces initiating devices and/or control circuits, indicating appliances and/or circuits, system control outputs, and other signaling line circuits to a signaling line circuit.
- J. Combination Detector: A device that either responds to more than one of the fire phenomenon or employs more than one operating principle to sense one of these phenomenon. Typical examples are a combination of heat detector with a smoke detector or a combination rate-of-rise and fixed-temperature heat detector.
- K. Digital Alarm Communicator Receiver (DACR): A system component that will accept and display signals from digital alarm communicator transmitters (DACT) sent over the public switched telephone network.

**SECTION 16721
MULTI-FIRE ALARM SYSTEM**

- L. Digital Alarm Communicator Transmitter (DACT): A system component at the protected premises to which initiating devices or groups of devices are connected. The DACT will seize the connected telephone line, dial a preselected number to connect to a DACR, and transmit signals indicating a status change of the initiating device.
- M. Fire Alarm Control Unit (FACU) (Panel): A system component that receives inputs from automatic and manual fire alarm devices and may supply power to detection devices and transponder(s) of off-premises transmitter(s). The control unit may provide transfer of power to the notification appliances and transfer of condition to relays or devices connected to the control unit. The fire alarm control unit can be a local fire alarm control unit or master control unit.
- N. Fire Alarm Signal: A signal initiated by a fire alarm initiating device such as a manual fire alarm box, waterflow switch, or other device whose activation is indicative of the presence of a fire or fire signature.
- O. Fire Alarm System: A system or portion of a combination system consisting of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal initiating devices and to initiate appropriate response to those signals.
- P. Initiating Device: A system component that originates transmission of a change of state condition, such as a smoke detector, manual fire alarm box, supervisory switch, etc.
- Q. Initiating Device Circuit: A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated.
- R. Labeled: Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the “authority having jurisdiction” and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
- S. Listed: Equipment or materials included in a list published by an organization acceptable to the “authority having jurisdiction” and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listed states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.
- T. Local Control Unit (Panel): A control unit that serves the protected premises or a portion of the protected premises and indicates the alarm via notification appliances inside the protected premises.
- U. Multiple Station Alarm Device: Two or more single-station alarm devices that may be interconnected so that actuations of one cause all integral or separate audible alarms to operate. It may also consist of one single-station alarm device having connections for other detectors or manual fire alarm box.
- V. Notification Appliance: A fire alarm system component such as a bell, horn, speaker, strobe, printer, etc., that provides an audible or visible output, or both.
- W. Positive Alarm Sequence: An automatic sequence that results in an alarm signal, even if manually delayed for investigation, unless the system is reset.
- X. Power Supply: A source of electrical operating power including the circuits and terminations connecting it to the dependent system components.

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- Y. Proprietary Fire Alarm System: An installation of fire alarm systems that serve continuous and noncontinuous properties under one ownership from a proprietary supervising station; power supplies; signal initiating devices; initiating device circuits; signal notification appliances; equipment for the automatic; permanent visual recording of signals; and equipment for initiating the operation of emergency building control services.
- Z. Remote Station Fire Alarm System: A system installed in accordance with this code to transmit alarm supervisory, and trouble signals from one or more protected premises to a remote location at which appropriate action is taken.
- AA. Signal: A status indication communicated by electrical or other means.
- AB. Signaling Line Circuit: A circuit or path between any combination or circuit interfaces, control units, or transmitters over which multiple system input signals or output signals, or both, are carried.
- AC. Supervising Station: A facility that receives signals and where personnel are in attendance at all times to respond to these signals.
- AD. Transmitter: A system component that provides an interface between signaling line circuits, initiating device circuits or control units and the transmission channel.
- AE. Trouble Signal: A signal initiated by the fire alarm system, indicative of a fault in a monitored circuit or component.
- AF. Zone: A defined area within the protected premises A zone may define an area from which a signal can be received, an area from which a signal can be sent, or an area in which a form of control can be executed.

1.4 SYSTEM DESCRIPTION:

- A. General: Complete, zoned, noncoded, addressable, microprocessor-based fire detection and alarm system with manual and automatic alarm initiation, and automatic alert.
- B. The fire alarm system shall allow for loading and editing special instruction and operating sequences as required. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
- C. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.
- D. Signal Transmission: A combination of hard-wired, using separate individual circuits for each zone of alarm initiation and alarm device operation as required, and multiplexing signal transmission for addressable alarm initiation and alarm device operation, dedicated to fire alarm service only.
- E. Audible Alarm Notification: By horns and bells for alarm zones indicated.
- F. System connections for alarm-initiation and alarm-indicating circuits shall be: Class A Wiring

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- G. Functional Description: The following are required system functions and operating features:
1. Priority of Signals: Accomplish automatic response functions by the first zone initiated. Alarm functions resulting from initiation by the first zone are not altered by subsequent alarms. The highest priority is an alarm signal. Priority two, Supervisory Service and Trouble signals have second, third, and fourth-level priority. Signals of a higher-level priority take precedence over signals of lower priority even through the lower-priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.
 2. Noninterfering: Zone, power, wire, and supervise the system so a signal on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACU after the initiating device or devices are restored to normal.
 3. Signal Initiation: The manual or automatic operation of an alarm initiating or supervisory-operating device shall cause the FACU transmit an appropriate signal including:
 - a. General alarm.
 - b. Fire-suppression alarm.
 - c. Manual station alarm.
 - d. Smoke detector alarm.
 - e. Heat detector alarm.
 - f. Fan shutdown.
 - g. System trouble.
 - h. Valve tamper supervisory.
 - i. Elevator Recall.
 - j. Elevator Shutdown.
 - k. Door Release.
 4. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided under another contract, using listed and approved equipment.
 5. Loss of primary power at the FACU shall sound a trouble signal at the FACU and remote annunciator and shall indicate at the both locations when the system is operating on an alternate power supply.
 6. Annunciation: Manual and automatic operation of alarm and supervisory initiating devices shall be annunciated both on the FACU and on the annunciator indicating the location and type of device.
 7. FACU Alphanumeric Display: Shall display plain-language description of alarms,

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trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.

8. General Alarm: A system general alarm shall include:
 - a. Indicating the general alarm condition at the FACU and the annunciator.
 - b. Identifying the zone that is the source of the alarm at the FACU and the annunciator.
 - c. Displaying the alarm on an 80 character LCD display. The system alarm LED shall flash on the control unit and the annunciator until the alarm has been acknowledged. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone shall flash the system alarm LED on the control unit and annunciator. The display shall show the new alarm information.
 - d. A pulsing alarm tone shall occur within the control unit and the annunciator until the event has been acknowledged.
 - e. Operating audible and visible alarm notification signals throughout the building.
 - f. Sounding a continuous fire alarm signal until silenced by the alarm silence switch at the control unit or at the annunciator.
 - g. All visible alarm notification appliances shall flash continuously until the System Reset Switch is operated.
 - h. Any subsequent zone alarm shall reactivate the alarm notification appliances.
 - i. Closing fire and smoke doors normally held open by magnetic door holders. All doors normally held open by 24 VDC door control devices shall release after a 15 second time delay.
 - j. Unlocking designated doors.
 - k. Stopping supply and return fans serving zone where alarm is initiated.
 - l. Closing smoke dampers on system serving zone where alarm is initiated.
 - m. Activating the air handling systems per life safety code, NFPA 90A and NEPA 101.
 - n. Initiate elevator automatic recall operation.
9. Water-flow alarm switch operation:
 - a. Initiates notification appliance operation.
 - b. Flashing of the device location – indicating light for the device that has operated.

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10. Sprinkler valve tamper switch operation shall cause or initiate the following:
 - a. The activation of any standpipe or sprinkler valve supervisory (tamper) switch shall activate the system supervisory service audible signal and illuminate the LED at the control unit and the annunciator. Differentiation between valve tamper activation and opens and/or grounds on the initiation circuit wiring shall be provided. The differentiation shall be clearly identified in plain-language on the FACU Alphanumeric display.
 - b. Pressing the Supervisory Service Acknowledge Key shall silence the supervisory audible signal while maintaining the Supervisory Service LED “on” indicating the off-normal condition.
 - c. A record of the event in the FACU historical log.
 - d. Transmission of supervisory signal to remote central station.
 - e. Restoring the valve to the normal position shall cause the Supervisory Service LED to extinguish, indicating restoration to normal.
 - (1) Permissible Signal Time Elapse: the maximum permissible elapsed time between the actuation of any fire alarm or fire-detection system alarm-initiating device and its indication at the FACU shall be five seconds.
 - (2) Circuit Supervision: Circuit faults shall be indicated by means of both a zone and a trouble signal at the FACU. Provide a distinctive indicating audible tone and alphanumeric annunciation
11. Alarm Silencing:
 - a. If the “Alarm Silence” button is pressed, all visual alarm signals shall cease operation and activates an “Alarm Silence” light. Display of identity of the alarm zone or device is retained.
 - b. Signals shall not be silenced during the 60 second alarm silence inhibit mode.
12. System Reset:
 - a. The “System Reset” button shall be used to return the system to its normal state after an alarm condition has been remedied. Display messages shall provide operator assurance of the sequential steps (“IN PROGRESS”, “RESET COMPLETED”) as they occur, should all alarm conditions be cleared.
 - b. Should an alarm condition continue, the system will remain in an alarmed state. System control relays shall not reset. The control unit alarm LED shall remain on. The alarmed points will not require acknowledgment if they were previously acknowledged.
 - c. Upon reset of the fire alarm control unit, air handling units shall sequentially start up to minimize power demand.

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13. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated. However, should an actual alarm occur, all alarm functions would occur as described previously.
14. Activation of an auxiliary bypass switch shall override the selected automatic functions.
15. Auxiliary manual controls shall be supervised so that an “off normal” position of any switch shall cause an “off normal” system trouble. The “off normal” status shall be clearly identified in plain-language on the FACU alphanumeric display.
16. Each independently supervised circuit shall include a discrete readout to indicate disarrangement conditions per circuit.
17. The System Modules shall be electrically supervised for module placement. Should a module become disconnected the system trouble indicator shall illuminate and the audible trouble signal shall sound.
18. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.
19. Power Requirements:
 - a. The control unit shall receive 120 VAC power via a dedicated fused disconnect circuit.
 - b. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
 - c. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control unit.
 - d. The incoming power to the system shall be supervised so that any power failure must be audibly and visibly indicated at the control unit and the graphic annunciator. A green “power on” LED shall be displayed continuously while incoming power is present.
 - e. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the control unit and the graphic annunciator.

1.5 SUBMITTALS:

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Product data for system components. Include dimensioned plans and elevations

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showing minimum clearances and installed features and devices. Include list of materials and NRTL-listing data.

- C. Wiring diagrams from manufacturer differentiating between factory and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Indicate components for both field and factory wiring.
- D. Shop drawings showing details of annunciator.
- E. System operation description covering this specific Project including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
- F. Operating instructions for mounting at the FACU.
- G. Operation and maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1. Include data for each type product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site. Provide the names, addresses, and telephone numbers of services organizations that carry stock of repair parts for the system to be furnished.
- H. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
- I. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component location to facilitate review. Upon receipt of comments from the Authority, submit them for review. Make resubmissions if required to make clarifications or revisions to obtain approval.
- J. Record of field tests of system.

1.6 QUALITY ASSURANCE:

- A. Installer Qualifications: A factory authorized Installer is to perform the Work of this Section.
- B. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations and the requirements of the authority having jurisdiction.
- C. Comply with NFPA 70, "National Electrical Code".
- D. NFPA Compliance: Provide fire alarm and detection systems conforming to the requirements of the following publications:
 - 1. NFPA 72, "National Fire Alarm Code"
- E. NRTL Listing: Provide systems and equipment that are listed and labeled.
 - 1. Terms "Listed" and "Labeled": As defined in the "National Electrical Code", Article 100.

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- 2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
- F. All control equipment must have transient protection to comply with UL864 requirements.
- G. Where Fire Alarm circuits leave the building, additional transient protection must be provided for each circuit. Devices must be UL listed under standard #497B (Isolated Loop Circuit Protectors).
- H. Single-Source Responsibility: Obtain fire alarm components from a single source ISO 9000 certified manufacturer who assumes responsibility for compatibility for system components.

1.7 MAINTENANCE SERVICE:

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months commencing with Substantial Completion, using factory-authorized service representatives.
- B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times coordinated with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturers replacement parts, components, and supplies.

1.8 EXTRA MATERIALS:

- A. General: Furnish extra materials, matching products installed (as described below), packaging with protective covering for storage, and identifying with labels clearly describing contents.
- B. Glass Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
- C. Lamps for Remote Indicating Lamp Panels: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
- D. Lamps for Strobe Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
- E. Printer Ribbons: Furnish 6 spare printer ribbons.
- F. Smoke detectors, fire detectors and flame detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.
- G. Detector Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.

PART 2. PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:

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1. Siemens
 2. Edwards Systems Technology
 3. Harrington
 4. Simplex
 5. Notifier
 6. ADT
- B. Being listed as an acceptable Manufacturer in no way relieves the Contractor obligation to provide all equipment and features in accordance with these specifications.
- C. If equipment of another manufacturer is submitted for approval, the contractor shall state how much is to be deducted from the base bid for the substitution, and also shall state what, if any, specific points of system operation differ from the specified points of the system operation. This differentiation report must reference every paragraph of this specification.

2.2 MANUAL PULL STATIONS:

- A. Description: Double action type, fabricated of high impact red LEXAN or metal, and finished in red with molded, raised-letter operating instructions of contrasting color. The manual station shall be fitted with screw terminals for field wire attachment. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units. Stations requiring the breaking of a glass panel are not acceptable. Stations requiring the breaking of a concealed rod may be provided.
- B. Station Reset: Key or wrench operated: Double pole, double throw, switch rated for the voltage and current at which it operates.

2.3 SMOKE DETECTORS:

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems". Include the following features:
1. Factory Nameplate: Serial number and type identification.
 2. Operating Voltage: 24-V d.c., nominal.
 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 4. Plug-In Arrangement: Detector and associated encapsulated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection requires no springs for secure mounting and contact maintenance. Terminals in the fixed base accept building wiring. Detector construction shall have a mounting base with a twist-lock detecting head that is lockable. The locking feature must be field removable when not required. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control

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Unit.

5. Remote controllability: Unless otherwise indicated, detectors are analog. Addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
 6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. The control Unit shall operate with the installed device but shall initiate a "Wrong Device" trouble condition until the proper type is installed or the programmed sensor type is installed or the programmed sensor type is changed.
 8. Visual Indicator: Connected to indicate detector has operated.
- B. Duct Smoke Detector: Ionization type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Detector includes relay as required for fan shutdown.
1. The Duct Housing shall provide an auxiliary alarm relay with two "Form C" contacts rated at 2A 28VDC or 120 VAC resistive. This auxiliary relay operates when the sensor reaches its alarm threshold, or when the control unit via software control, manually or automatically operates the relay in response to inputs from other devices.
 2. Each duct detector shall have a Remote Test Station with an alarm LED and test switch.
 3. Photoelectric smoke detector: Include the following features:
 - a. Sensor: An infrared detector light source with matching silicon cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent – per - foot smoke obscuration when tested according to UL 268.

2.5 OTHER DETECTORS:

- A. Thermal Detector: Combination fixed-temperature and rate-of-rise unit with mounting plate arranged for outlet box mounting; 135-deg F fixed-temperature setting except as indicated, or rate of rise of temperature that exceeds 15 deg. per minute.

2.6 ALARM-NOTIFICATION APPLIANCES:

- A. General: Equip alarm-notification appliances for mounting as indicated. Provide terminal blocks for system connections.
- B. Fire Alarm Horns: Electric-vibrating polarized type, operating on 24-V d.c., with provision for housing the operating mechanism behind a grille. Horns produce a sound pressure level of 90 dB, measured 10 feet from the source.

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- C. Visual Notification Appliances: 30, or 75 or 110 candela-Second Xenon flash output, 24 VDC operation, wall mounted, compatible with ADA requirements with "FIRE" printed vertically.
1. Combination notification appliances consist of factory-combined, audible and visual notification units in a single mounting assembly.

2.7 MAGNETIC DOOR HOLDERS:

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Electromagnetic operates from 24-V d.c. source, and develops a 25 lbs. holding force.
- B. Material and Finish: Match door hardware.

2.8 FIRE ALARM CONTROL UNIT (FACU):

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures. Accommodate all components and allow ample gutter space for interconnection of units as well as field wiring. Identify each enclosure by an engraved, red-laminated, phenolic resin nameplate. Lettering on the enclosure nameplate shall not be less than 1-inch high.
- C. Systems: Alarm and supervisory systems are separate and independent in the FACU. The alarm-initiating zone boards in the FACU consist of plug-in modules. Construction requiring removal of field wiring for module replacement is not acceptable.
- D. Control Modules: Types and capacities required to perform all functions of the fire alarm systems plus 20% for future expansion. Local, visible, and audible signals notify of alarm, supervisory, and trouble conditions. Each type of audible alarm has a distinctly different sound.
- E. Zones: Provide for all alarm and supervisory zones indicated.
- F. Instruction: Printed or typewritten instruction card mounted behind a LEXAN plastic or glass cover in a painted steel or aluminum frame. Install the frame in a location observable from the FACU. Include interpretation and appropriate response for displays and signals, and briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- G. Resetting: Provide the necessary controls to prevent the resetting of any alarm, supervisory or trouble signal while the alarm or trouble condition still exists.

2.9 ANNUNCIATOR:

- A. Indicating Lights: Provide individual LED devices for each zone. An LED test switch for each FACP section illuminates all LED devices on that section of the control panel. Manual toggle test switches or push test-buttons do not require a key to operate. Alarm and supervisory signals light a red LED of the associated zone. Trouble signals light an

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amber LED for the associated zone.

2.10 WIRE:

- A. Line-Voltage and Low-Voltage Circuits: Solid copper conductors with 600 V-rated insulation.

2.11 TAGS:

- A. Tags for identifying tested components: Comply with NFPA 72.

PART 3. EXECUTION**3.1 INSTALLATION, GENERAL:**

- A. Install system according to NFPA Standards referenced in Parts 1 and 2 of this Section.
- B. Fire Alarm Power Supply Disconnect: Shall be painted red and labeled "FIRE ALARM". Provide with a lockable handle or cover.

3.2 EQUIPMENT INSTALLATION:

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans; to be wired, connected, and left in first class operating condition. Include sufficient control unit, annunciator, manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliance, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
- B. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.
- C. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inches from a side wall to the near edge. Install detectors located on the wall at least 4 inches but not more than 12 inches below the ceiling. For exposed solid joist construction, mount detectors on the bottoms of the joists. On smooth ceilings, install detectors not over 30 feet apart in any direction. Install detectors no closer than 5 feet from air registers.
- D. Audible Notification Appliances: Install no less than 80 inches above the finished floor nor less than 6 inches below the ceiling. Install bells and horns on flush mounted back boxes with the device-operating mechanism concealed behind a grille or as indicated. Combine audible and visual notification appliances at the same location into a single unit.
- E. Visual Notification Appliances: Install adjacent to each alarm bell or alarm horn and not less than 80 inches above the finished floor and at least 6 inches below the ceiling.
- F. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
- G. Fire Alarm Control Unit (FACU): Surface mount with tops of cabinets not more than 6 feet above the finished floor.

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- H. Annunciator: Arrange as indicated, with the top of the unit no more than 6 feet above the finished floor.
- I. Manual Pull Stations: Mount semiflush in recessed back boxes.

3.3 WIRING INSTALLATION:

- A. Wiring Method: Install wiring in metal raceway according to Division 16 Section "Raceways". Conceal raceway except in unfinished spaces and as indicated.
- B. Wiring within Enclosures: Separate power-limited and non power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where an circuit tap is made.
- D. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of the National Electric Code (NEC) (NEPA 70). It is the Contractor's responsibility to obtain from the Fire Alarm System Manufacturer's written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- E. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.
- F. Fan Shutdown: Air handling equipment shall be connected to relays in its respective duct smoke detector.

3.4 GROUNDING:

- A. Ground equipment and conductor and cable shields as specified by the equipment manufacturer. For audio circuits, minimize to the greatest extent possible ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record and report ground resistance.
- B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

3.5 FIELD QUALITY CONTROL:

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the

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pretesting, testing and adjustment of the system. Report results in writing.

- B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.
- D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
- E. Minimum System Tests: Test: test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Test all conductors for short circuits utilizing an insulation-testing device.
 - 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
 - 4. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
 - 5. Test initiating, notification, and signaling circuits for proper signal transmission under open circuit conditions. One connection each should be opened at no less than 10 percent of the initiating and notification devices. Observe proper signal transmission according to class of wiring used.
 - 6. Test each initiating device and notification appliance for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - 7. Test the system for all specified functions according to the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
 - 8. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by

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such deficiencies. Verify by the system meets the Specifications and complies with applicable standards.

- G. Report of Test and Inspections: Provide a written record of inspections, test, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.
- H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.
- I. Final Test, Certificate of Completion, and Certificate of Occupancy:
 - 1. Test the system as required by the Authority having jurisdiction in order to obtain a certificate of occupancy. Demonstrate that the system meets the Specifications and complies with applicable standards. This final test shall be witnessed by a representative and a factory-authorized service representative.

3.6 CLEANING AND ADJUSTING:

- A. Cleaning: Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.7 TRAINING:

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
 - 2. Schedule training with the Owner at least seven days in advance.
 - 3. Training Aid: Use the Approved Final Version of the Operation and Maintenance Manual as a training aid.

END OF SECTION