PROJECT MANUAL

Divisions 01-27

Steamboat Base Village Redevelopment

2305 Mount Werner Circle
Steamboat Springs, CO 80487

BP1B-IT Room - Issue for Permit and Bid
February 5, 2021

Project Number: 003.7651.000

Prepared by
Gensler
1225 17th Street
Suite 150
Denver, Colorado 80202
Tel 303.595.8585

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DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING(HVAC)

DIVISION 25 - INTEGRATED AUTOMATION

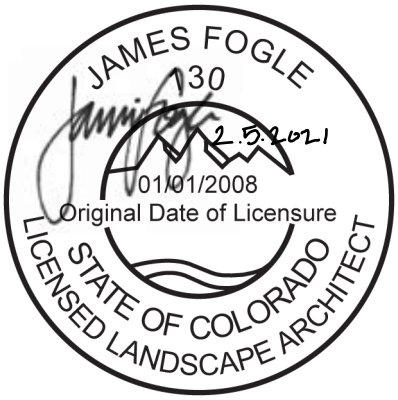
DIVISION 26 - ELECTRICAL

ARCHITECT
Gensler
1225 17th St.
Suite 150
Denver, CO. 80202
303.595.8585

Structural Engineer
Martin/ Martin
12499 West Colfax Ave.
Lakewood, CO. 80215
303.431.6100

February 5, 2021

Landscape Architect
Design Workshop
1390 Lawrence St.
Suite 100
Denver, CO. 80204
303.623.5186



Mechanical, Electrical, Plumbing, Teledata
ME Engineers
1413 Denver West Pkwy
Suite 300'
Golden, CO
303.421.6655

Division 26 & 28 specifications.

02/05/2021

Division 21, 22, and 23 specifications.

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Specification and drawing conventions.
4. Miscellaneous provisions.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to the Work of all Sections in the Specifications. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all.

B. Conflicts or discrepancies among the Contract Documents shall be resolved in the following order of priority:

1. Contract modifications (such as Change Orders and Bulletins) of later date take precedence over those of earlier date.
2. The Agreement.
3. Addenda of later date take precedence over those of earlier date.
4. The Supplementary Conditions.
5. The General Conditions.
6. Drawings and Specifications; Drawings govern Specifications for quantity and location. Specifications govern Drawings for quality and performance. In the event of ambiguity or conflicts, the greater quantity and the better quality shall govern.

1.3 PROJECT INFORMATION

A. Project Identification: Steamboat Base Village Redevelopment BP1B-IT Permit and Bid Package.

1. Project Location: 2305 Mount Werner Circle, Steamboat Springs, CO. 80487.

B. Owner: Alterra Mountain Company

1. Owner's Representative: Mike Schmidt, Vice President of Development, MSchmidt@alterramtnco.com, 303.749.8262,

C. Architect: Jon Gambrill, Principal in Charge, jon_gambrill@gensler.com, 303.595.8585.

1. Design Workshop, landscape architect, Becky Zimmerman, President, bzimmerman@designworkshop.com, 303.625.5186

D. Project Web Site: A project Web site administered by Contractor will be used for purposes of managing communication and documents during the construction stage.

1. See Section 01 31 00 "Project Management and Coordination" for requirements for establishing, administering, and using the Project Web site.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of constructing a new Data Center/ IT Server room and exterior generator and mechanical equipment screened yard. Work to include Structural, Mechanical, Electrical, Fire Protection, Architecture, access control, Tele data, and Landscape scope

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.

3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 14 00 - WORK RESTRICTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Existing utility interruptions.
2. Use of premises.
3. Occupancy requirements during construction.
4. Occupancy requirements prior to Substantial Completion.
5. Miscellaneous restrictions.

1.3 EXISTING UTILITY INTERRUPTIONS

A. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Owner not less than 5 days in advance of proposed utility interruptions.
2. Obtain Owner's written permission before proceeding with utility interruptions.

1.4 USE OF PREMISES

A. Access: At all times, provide the Architect and the Owner's representatives, easy and safe access to the Work wherever it is in preparation and progress. Provide such access so Architect may perform its functions. Provide access to any testing agencies to perform required testing.

B. Property Manager's Rules: Conform at all times to the Owners requirements for protection of plant, materials, equipment, and noise levels. A copy of the Owners rules will be furnished from the Owner upon written request.

C. Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

D. Use of Site: Confine operations at the site to areas permitted by law, ordinances, permits, and the Contract Documents. Do not unreasonably encumber the Site with any materials or equipment. Coordinate loading on floor or roof with Architect and/or Structural Engineer to assure that no surfaces exceed carrying capacity.

1. Coordinate with Owner for secured storage within the building, if applicable.
2. Protect and maintain common areas of the building that are in the path of travel for construction personnel and used for transporting materials and equipment to and from the construction site.
3. Limits: Confine constructions operations to Contract Limits.

    a. Limit site disturbance, including earthwork and clearing of vegetation, to 40 feet beyond building perimeter; 10 feet beyond surface walkways, patios, surface parking, and utilities; less than 12 inches in diameter; 15 feet beyond primary roadway curbs and main utility branch trenches; and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require staging areas in order to limit compaction in the constructed area.

4. Driveways and Entrances: Keep driveways, parking lots, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

5. Do not block entrances, fire exits or lanes, or delivery routes.
6. Limit use of driveways and entrances to the following times:

    a. Work hours as defined by Owner.

E. On-Site Work Hours: Limit work in the existing building to normal business working hours, Monday through Friday, as defined by Owner, unless otherwise indicated.

1. Hours for Noise-Generating, Odor-Generating, and Dust-Generating Activities and Demolition: After business hours, or at such times as approved by the Owner.

    a. Noise- and Odor-Generating activities include, but are not limited to, sprinkler work, concrete saw cutting, core drilling, spray painting, hammering, nailing, and similar work, which may cause noise, dust, or odors, thereby disturbing occupants.

F. Condition in Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

1.5 OCCUPANCY REQUIREMENTS DURING CONSTRUCTION

A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.
3. Schedule use of premises for Work and coordinate construction operations with the Owner to allow for Owner occupancy.
4. Schedule use of premises for Work and coordinate construction operations with the Owner to allow for use of site and premises by the public.
5. Keep premises orderly, clean and with a minimum of obstruction and inconvenience to the tenants and the public.
6. Relocate any stored products that interfere with public access, operations of the Owner or separate contractor. If necessary, obtain and pay for additional storage or work areas needed for operations.

1.6 OCCUPANCY REQUIREMENTS PRIOR TO SUBSTANTIAL COMPLETION

A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior Owner acceptance of the completed Work.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will provide, operate, and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.7 MISCELLANEOUS RESTRICTIONS

A. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.

1. Notify Owner not less than 5 days in advance of proposed disruptive operations.
2. Obtain Owner's written permission before proceeding with disruptive operations.

B. Controlled Substances: Use of tobacco products and other controlled substances within the existing building on Project site is not permitted.

C. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

D. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.

1. Maintain list of approved screened personnel with Owner's representative.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 14 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Sections:

1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
2. Divisions 02 through 49 Sections for specific requirements and limitations for substitutions.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use facsimile of "Substitution Request" form provided in Document 00 60 00 "Forms."
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication, or installation cannot be provided, if applicable.
b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES and local regulations.
j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 10 working days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Bulletin for minor changes in the Work.
b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

    a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    b. Requested substitution provides sustainable design characteristics that specified product provided.
    c. Substitution request is fully documented and properly submitted.
    d. Requested substitution will not adversely affect Contractor's construction schedule.
    e. Requested substitution has received necessary approvals of authorities having jurisdiction.
    f. Requested substitution is compatible with other portions of the Work.
    g. Requested substitution has been coordinated with other portions of the Work.
    h. Requested substitution provides specified warranty.
    i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed, unless otherwise indicated.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Architect may issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on "Bulletin" form included in Document 00 60 00 "Forms."

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Bulletins with "Architect's Request for Contractor's Proposal" indicated, issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Bulletin after receipt of Bulletin, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include costs of labor and supervision directly attributable to the change.
d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
e. Quotation Form: Use forms acceptable to Architect.

B. Contractor-Initiated Proposals (Change Order Request): If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Changes Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Sections include the following:

1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
2. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule.

1.3 DEFINITIONS

A. Site Visit: Architect's visits to the site at intervals necessary in the judgment of Architect to become generally familiar with the progress and quality of the Work completed and to determine in general if the Work completed is in accordance with the Contract Documents. Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work.

B. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:

a. Application for Payment forms with Continuation Sheets.

b. Submittals Schedule.
c. Items required to be indicated as separate activities in Contractor's Construction Schedule.

2. Submit the Schedule of Values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Sub schedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide sub schedules showing values correlated with each phase of payment.
4. Sub schedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide sub schedules showing values correlated with each element.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one-line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:

a. Project name and location.
b. Name of Architect.
c. Architect's project number.
d. Project Manager's name and address.
e. Contractor's name and address.
f. Date of submittal.

2. Arrange schedule of values consistent with format of AIA Document G703.
3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

a. Related Specification Section or Division.
b. Description of the Work.
c. Name of subcontractor.
d. Name of manufacturer or fabricator.
e. Name of supplier.
f. Change Orders (numbers) that affect value.
g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

1) Labor.
2) Materials.
3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of Contract Sum. Break down principal subcontract amounts into separate labor and materials items. Breakdown of subcontractor's schedule of values must be true and accurate.
5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.

7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Include separate line items under Contractor and principal subcontracts Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
9. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.

10. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.

    1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date of each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts of work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
4. Indicate separate amounts for work being carried out under Owner-requested project acceleration, if any.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and off-site.

1. Provide description of item(s) being stored.
2. Location of the bonded warehouse(s) where materials or equipment is stored.
3. Bill of sale made to Owner stating there will be no additional cost for transportation and delivery of the stored item(s).
4. Statement certifying that item, or any part thereof will not be installed in any construction other than Work under this Contract.
5. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
6. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
7. Provide summary documentation for stored materials indicating the following:

    a. Materials previously stored and included in previous Applications for Payment.
    b. Work completed for this Application utilizing previously stored materials.
    c. Additional materials stored with this Application.
    d. Total materials remaining stored, including materials with this application.

F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit notarized waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested, before deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors, principal suppliers, and fabricators.
2. Schedule of Values.
3. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
4. Products list (preliminary if not final).
5. Submittals Schedule (preliminary if not final).
6. List of Contractor's staff assignments.
7. List of Contractor's principal consultants.
8. Copies of building permits.
9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
10. Initial progress report.
11. Report of preconstruction conference.
12. Certificates of insurance and insurance policies.
13. Performance and payment bonds.
14. Data needed to acquire Owner's insurance.
15. Initial settlement survey and damage report if required.
16. Construction waste management program.

I. Application for Payment at Substantial Completion: After issuance of the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements, including, but not limited to:

a. Transmittal of required Project Record Documents to Owner.
b. Evidence of completion of demonstration and training.

2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.
10. Occupancy permits and similar approvals or certifications by governing authorities and franchised services, assuring Owner's full access and use of completed work.

1.6 REVIEW OF APPLICATION FOR PAYMENT

A. Draft Copy: Submit draft (pencil) copy of the Application for Payment ten days prior to due date for review by Architect.

B. Upon receipt of the official Application for Payment and other documentation as required by the Architect, including the updated Schedule of Values and the updated Contractor's Construction Schedule if required, the Architect shall review the documents received to determine if they correspond to the agreements reached during the draft copy review meeting.

C. The Architect will rely on the accuracy and completeness of the information furnished by the Contractor. Issuance of a Certificate of Payment will not be deemed to represent that the Architect performed audits of the supporting data.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections

1. Section 23 05 01 / 26 05 01 'Mechanical Electrical Coordination" for additional requirements for coordination drawings and procedures.

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General project coordination procedures.
2. Coordination Drawings.
3. Project Web site.
4. Administrative and supervisory personnel.
5. Project meetings.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting the Contractor's Construction Schedule.
2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Section 01 77 00 "Closeout Procedures" for coordinating Contract closeout.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities or as specified in individual Sections.

1. Indicate relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.

B. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A in Document 00 60 00 "Forms." Include the following information in tabular form:

1. Name, address, and telephone number of entities performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

C. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, on Project Web site, and by each temporary telephone. Keep list current at all times.

1.4 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Arrange pipes, ducts, conduits, and other overhead systems in an orderly manner when indicated to remain exposed.

B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.

3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
f. Indicate required installation sequences.
g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.

2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts, and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
    d. Location of pull boxes and junction boxes dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00 "Submittal Procedures."

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
3. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.

    a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
    b. Digital data files will be provided in the software and format that is used to prepare the Contract Documents. Translations to different programs or modifications to the drawing setup will be the responsibility of the Contractor.
    c. Contractor shall execute a data licensing agreement in using the "Gensler Data Transfer Agreement".

1.6 PROJECT WEB SITE

A. The Contractor shall provide, administer, and use a Project Web site for purposes of hosting and managing project communication and documentation until Final Completion. Project Web site shall include the following functions:

1. Project directory.
2. Project correspondence.
3. Meeting minutes.
4. Contract modifications forms and logs.
5. RFI forms and logs.
6. Task and issue management.
7. Photo documentation.
8. Schedule and calendar management.
9. Submittals forms and logs.
10. Payment application forms.
11. Drawing and specification document hosting, viewing, and updating.
12. Online document collaboration.
13. Reminder and tracking functions.
14. Archiving Function

B. Provide Project Web site user licenses for use of the Owner, Owner's Commissioning Authority, Architect, and Architect's consultants. Provide eight hours of software training online for Project Web site users.

C. On completion of Project, provide one complete archive copy of Project Web site files to Owner and to Architect in a digital storage format acceptable to Architect.

D. Provide one of the following Project Web site software packages under their current published licensing agreements:

1. Autodesk, BIM 360 Docs.
2. Procore Technologies.

3. Contractor specific web site software that meets the listed requirements.

E. Contractor, subcontractors, and other parties granted access by Contractor to Project Web site shall execute a data licensing agreement in the form of Agreement acceptable to Owner and Architect.

1.7 PROJECT MEETINGS

A. General: General Contractor will schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
4. Notification: Inform participants three days prior to meetings not regularly scheduled.

B. Preconstruction Conference: a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, if one is retained by Owner, and Architect, but no later than 15 days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; testing laboratory representatives; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Requirements in individual Specification Sections for preconstruction responsibilities.
    b. Tentative construction schedule.
    c. Project coordination
    d. Critical work sequencing and long-lead items.
    e. Designation of key personnel and their duties.
    f. Lines of communication.
    g. Procedures for processing Requests for Interpretation (RFIs.)
    h. Procedures for processing Bulletins.
    i. Procedures for processing submittals.
    j. Procedures for processing substitution requests.
    k. Procedures for processing field decisions, proposal requests and Change Orders.
    l. Procedures for testing and inspecting.
    m. Procedures for processing Applications for Payment.

n. Distribution of the Contract Documents.
o. Preparation of Record Documents.
p. Use of the premises and existing building.
q. Work restrictions.
r. Working hours.
s. Owner's occupancy requirements.
t. Responsibility for temporary facilities and controls.
u. Procedures for moisture and mold control.
v. Procedures for disruptions and shutdowns.
w. Construction waste management and recycling.
x. Office, work, and storage areas.
y. Equipment deliveries and priorities.
z. First aid.
aa. Security.
bb. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.
b. Options.
c. Related RFI.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility requirements.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.

s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: a project closeout conference, at a time convenient to Owner and Architect, but no later than 30 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of record documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.
d. Requirements for preparing operations and maintenance data.
e. Requirements for delivery of material samples, attic stock, and spare parts.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Submittal procedures for closeout documents.
j. Owner's partial occupancy requirements.
k. Installation of Owner's furniture, fixtures, and equipment.
l. Responsibility for removing temporary facilities and controls.

E. Progress Meetings: progress meetings at weekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.

2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

        1) Review schedule for next period.

    b. Review present and future needs of each entity present, including the following:

        1) Interface requirements.
        2) Sequence of operations.
        3) Resolution of BIM component conflicts.
        4) Status of submittals.
        5) Deliveries.
        6) Off-site fabrication.
        7) Access.
        8) Site utilization.
        9) Temporary facilities and controls.
        10) Work hours.
        11) Hazards and risks.
        12) Progress cleaning.
        13) Quality and work standards.
        14) Pending changes
        15) Status of Change Orders.
        16) Pending claims and disputes.
        17) Documentation of information for payment requests.
        18) Testing and inspection requirements.
        19) Status of Request for Information.
        20) Other business relating to the Work.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.

a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's construction schedule.
2. Daily construction reports.
3. Material location reports.
4. Site condition reports.
5. Special reports.

B. Related Sections include the following:

1. Section 01 29 00 "Payment Procedures" for submitting the Schedule of Values.
2. Section 01 31 00 "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
3. Section 01 33 00 "Submittal Procedures" for submitting schedules and reports.
4. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
2. Predecessor activity is an activity that must be completed before a given activity can be started.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

H. Major Area: A story of construction, a separate building, or a similar significant construction element.

I. Milestone: A key or critical point in time for reference or measurement.

J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format, unless indicated otherwise:

1. PDF electronic file.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

C. Construction Schedule Updating Reports: Submit with each Application for Payment.

D. Site Condition Reports: Submit at time of discovery of differing conditions.

E. Special Reports: Submit at time of unusual event.

1.5 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

C. Coordinate Contractor's construction schedule with Owner's construction schedule for Owner's own forces. Revise Contractor's construction schedule, if necessary, after a joint review and mutual agreement. The construction schedule shall then constitute the schedule to be used by Contractor, separate contractors, and Owner until subsequently revised.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for commencement of the Work to date of Final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.

1. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.

C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion

1. .

D. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered RFI.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

E. Recovery Schedule: When periodic update indicates the Work is 10 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

F. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules. Coordinate with Architect regarding which project management software will be used on the Project.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Startup Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's Construction Schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.

    a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.

4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Purchase of materials.
    d. Delivery.
    e. Fabrication.
    f. Utility interruptions.
    g. Installation.
    h. Work by Owner that may affect or be affected by Contractor's activities.
    i. Testing and commissioning.
    j. Punch list and final completion.
    k. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Principal events of activity.
4. Immediately preceding and succeeding activities.

5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the Schedule of Values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

2.3 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. Approximate count of personnel at Project site.
3. Equipment at Project site.
4. Material deliveries.
5. High and low temperatures and general weather conditions, including rain or snow accumulation.
6. Accidents.
7. Meetings and significant decisions.
8. Unusual events (refer to special reports).
9. Stoppages, delays, shortages, and losses.
10. Meter readings and similar recordings.
11. Tests and inspections, including name(s) of testing and inspection agency(ies).
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial Completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At weekly intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare a detailed report. Submit with a Request for Interpretation (RFI). Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare, and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate Actual Completion percentage for each activity.
4. Notify Owner and Architect a minimum of one week prior to issuance of updated schedule of all anticipated significant revisions to the Construction Schedule.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post electronic copies of the updated project schedule on the project website.
2. Post copies in Project meeting rooms and temporary field offices.
3. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "As Required": As required by regulatory bodies, by referenced standards, by existing conditions, by generally accepted construction practice or by the Contract Documents. In the event of ambiguity or conflicts, the most stringent requirements shall apply.

J. "By Others" refers to work that is not a part of the Contract.

K. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

L. "NIC": "Not in Contract" means the work or the item indicated is not a part of the Contract and will be provided by the Owner.

M. "Day": Unless stated otherwise, "day" means a calendar day.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, except comply with standards having different revision dates as referenced in the codes as indicated on Drawings.

C. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 02 41 16 "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements.
2. Section 02 41 19 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.
3. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.

1.2 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 50 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:

a. Asphalt paving.
b. Concrete.
c. Concrete reinforcing steel.
d. Brick.
e. Concrete masonry units.
f. Wood studs.
g. Wood joists.
h. Plywood and oriented strand board.
i. Wood paneling.
j. Wood trim.
k. Structural and miscellaneous steel.
l. Rough hardware.
m. Roofing.
n. Insulation.
o. Doors and frames.
p. Door hardware.
q. Windows.
r. Glazing.
s. Metal studs.
t. Gypsum board.
u. Acoustical tile and panels.
v. Carpet.
w. Carpet pad.
x. Demountable partitions.
y. Equipment.
z. Cabinets.
aa. Plumbing fixtures.
bb. Piping.
cc. Supports and hangers.
dd. Valves.
ee. Sprinklers.
ff. Mechanical equipment.
gg. Refrigerants.
hh. Electrical conduit.
ii. Copper wiring.
jj. Lighting fixtures.
kk. Lamps.

ll. Ballasts.
mm. Electrical devices.
nn. Switchgear and panelboards.
oo. Transformers.

2. Construction Waste:

a. Masonry and CMU.
b. Lumber.
c. Wood sheet materials.
d. Wood trim.
e. Metals.
f. Roofing.
g. Insulation.
h. Carpet and pad.
i. Gypsum board.
j. Piping.
k. Electrical conduit.
l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Plastic pails.

1.4 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 10 days of date established for commencement of the Work.

1.5 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste and Form CWM-8 for demolition waste. Include the following information:

1. Material category.
2. Generation points of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.

5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use Form CWM-3 for construction waste and Form CWM-4 for demolition waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Reclamation Programs: Research and prepare a plan to work with manufacturers who have programs to receive used materials. Known reclamation programs are available from, but not limited to, the following manufacturers:

1. Carpet:

a. Reentry Program by Interface.
b. Antron, In vista.
c. CON-tinuum by Constantine & Covanta.

d. Local carpet and carpet cushion reclamation centers may be found on http://www.carpetrecovery.org/.

2. Ceiling Panels: Armstrong World Industries, Inc.
3. Resilient Flooring: ReUse Program by Tarkett.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

B. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

C. Plumbing Fixtures: Separate by type and size.

D. Lighting Fixtures: Separate lamps by type and protect from breakage.

E. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

    a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum 4-inch size.

B. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Pulverize masonry to maximum 1-1/2-inch 4-inch size.

C. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

D. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

E. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

F. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

G. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

H. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

I. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

J. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

K. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

3.7 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

C. Form CWM-3 for construction waste reduction work plan.

D. Form CWM-4 for demolition waste reduction work plan.

E. Form CWM-7 for construction waste

F. Form CWM-8 for demolition waste.

END OF SECTION 01 74 19

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout.

1.2 ACTION SUBMITTALS

A. Contractor's List of Incomplete Items (Punch List): Initial submittal at Substantial Completion.

B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

A. Certificate of Insurance: For continuing coverage.

B. Project Record Documents:

1. Record Drawings.
2. Record Specifications.
3. Record product data.
4. Miscellaneous record submittals.

C. Operation and maintenance manual(s).

D. Warranties.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.5 SUBSTANTIAL COMPLETION PROCEDURES

A. Submittals Prior to Substantial Completion: Complete the following a minimum of 5 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Prepare and submit a list of incomplete items (punch list), indicating the value of items on the list, and reasons why the Work is not complete.
2. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, final certifications, and similar documents.
3. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
4. Prepare and submit Project Record Documents, operation and maintenance manuals, and similar final record information.
5. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number where applicable.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.

6. Submit test/adjust/balance records.

B. Procedures Prior to Substantial Completion: Complete the following prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request

1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
6. Advise Owner of changeover in utility services.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project sire, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

C. Inspection: Submit a written request for inspection for Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.6 FINAL COMPLETION PROCEDURES

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment.
2. Submit copy of Contractor's original Substantial Completion inspection list with Architect's annotations of items to be completed or corrected (punch list), endorsed and dated by Architect. Copy shall be certified by Contractor and state that each item has been completed or otherwise resolved for acceptance.

B. Inspection: Submit a written request for final inspection for acceptance a minimum of 5 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect.
    d. Name of Contractor.
    e. Page number.

B. Submit list of incomplete items in MS Excel electronic file. Architect will return annotated electronic file.

1.8 PROJECT RECORD DOCUMENTS

A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.

1. Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up record prints.

    a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later, and the locations of those items that need to be located for servicing.
    b. Accurately record information in a readily understandable drawing technique.
    c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
    d. Mark record prints completely and accurately.
    e. Mark important additional information that was either shown schematically or omitted from original Drawings.
    f. Note Change Order numbers, alternate numbers, and similar identification where applicable.

C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Clearly mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Note related Change Orders, Record Drawings, and Product Data, where applicable.

D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Drawings, where applicable.

E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections such as tests and inspections, and inspections by authorities having jurisdiction. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:

1. Operation Data:

    a. Emergency instructions and procedures.
    b. System, subsystem, and equipment descriptions, including operating standards.
    c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
    d. Description of controls and sequence of operations.
    e. Piping diagrams.
    f. Noise and vibration adjustments.
    g. Effective energy utilization.

2. Maintenance Data:

    a. Manufacturer's information, including list of spare parts.
    b. Name, address, and telephone number of Installer or supplier.
    c. Maintenance procedures.
    d. Maintenance and service schedules for preventive and routine maintenance.
    e. Maintenance record forms.
    f. Sources of spare parts and maintenance materials.
    g. Copies of maintenance service agreements.
    h. Copies of warranties and bonds.
    i. Cleaning.
    j. Control sequence.
    k. Fuels, lubricants, tool, and other related items.
    l. Identification systems.

B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

1.10 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period.

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 01 77 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory manuals.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

B. Related Requirements:

1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Section 01 91 13 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.

E. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary, to provide essential information for proper operation or maintenance of equipment or system.
    b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold, and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.

3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.

4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name, and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

    a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name, and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Section 01 73 00 "Execution" for final property survey.
2. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
3. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit copies of record Drawings as follows:

a. Final Submittal:

1) Submit record digital data files and three set(s) of record digital data file plots.
2) Plot each drawing file, whether or not changes and additional information were recorded.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

1.4 RECORD DRAWINGS

A. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Annotated PDF electronic file with comment function enabled.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Architect through Construction Manager for resolution.
4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.

    a. See Section 01 31 00 "Project Management and Coordination" for requirements related to use of Architect's digital data files.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Architect.
    e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file paper copy.

1.6 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

C. Format: Submit record Product Data as annotated PDF electronic file.

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.8 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

a. Name of Project.
b. Name and address of videographer.
c. Name of Architect.
d. Name of Construction Manager.

e. Name of Contractor.
f. Date of video recording.

2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
4. At completion of training, submit complete training manual(s) for Owner's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 01 78 23 "Operation and Maintenance Data."

1.5 QUALITY ASSURANCE

A. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.7 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor has delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Systems and equipment operation manuals.
    c. Systems and equipment maintenance manuals.
    d. Product maintenance manuals.
    e. Project Record Documents.
    f. Identification systems.
    g. Warranties and bonds.
    h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.

d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:

   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning.
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:

   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written a demonstration performance-based test.

F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 79 00

SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.

B. Related Requirements:

1. Section 01 10 00 "Summary" for use of the premises and Owner occupancy requirements.
2. Section 01 14 00 "Work Restrictions" for restrictions on use of the premises due to Owner or tenant occupancy.
3. Section 01 32 00 "Construction Progress Documentation" for preconstruction photographs taken before selective demolition.
4. Section 01 50 00 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for selective demolition operations.
5. Section 01 73 00 "Execution" for cutting and patching procedures.
6. Section 01 74 19 "Construction Waste Management and Disposal" for disposal of demolished materials.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed, and salvaged, or removed and reinstalled.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.4 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property for dust control and for noise control. Indicate proposed locations and construction of barriers.

B. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Submit before Work begins.

1.6 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Before selective demolition, Owner will remove the following items:

a. All existing stored items, equipment, and storage bins and shelving. Owner shall empty the area prior to contractor executing the work.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:

1. .

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.8 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. If available, review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate, and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 01 14 00 "Work Restrictions."

B. Existing Services/Systems to be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off indicated utilities with utility companies.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

    a. Piping to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    c. Equipment to be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

h. Fire Suppression System Partial or Complete Removal: Arrange for bypass of area to be removed so that overall building fire suppression system remains in operation. If continuous operation is not possible, coordinate with local Fire authorities; maintain Firewatch during removal operations and until system can be restored to working order. Maintain fire extinguishers on the site.

C. Ballasts: If ballast is not labeled "No PCBs," or if the label is illegible, contact a ballast recycler for disposal.

D. Mercury-Containing Devices: Mercury-containing devices include thermostats, silent switches, mechanical switches and relays or contacts. Dispose of these devices with an appropriate recycler.

E. Nickel-Cadmium and Lead-Acid Batteries: Exit signs, emergency lighting units, alarm systems, smoke detectors and carbon-monoxide detectors may contain nickel-cadmium or lead-acid. Arrange with an appropriate recycler for disposal.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 "Temporary Facilities and Controls."

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering, and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations, and for duration required by Authorities Having Jurisdiction hours after completion of flame cutting operations and other "hot work" as defined by NFPA 51B.
4. Maintain adequate ventilation when using cutting torches.
5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
6. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
7. When cutting concrete, masonry, wallboard, and any other dust-producing materials, provide temporary barriers to prevent spread of dust into the rest of the building. Provide filters for mechanical systems and air ducts.
8. Dispose of demolished items and materials promptly. Comply with requirements in Section 01 74 19 "Construction Waste Management and Disposal."

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

B. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction. and recycle or dispose of them according to Section 01 74 19 "Construction Waste Management and Disposal."

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

4. Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Refer to Section 01 73 00 "Execution" for progress cleaning.

END OF SECTION 02 41 19

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete toppings.

B. Related Sections:
1. Section 07 18 00 “Traffic Coatings, for traffic coating on concrete roof.
2. Section 07 26 16 “Under Slab-On Grade Vapor Retarder” for vapor retarder to be placed under new concrete

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.
2. Submit substantiating data for each concrete mix design contemplated for use to the Architect no less than four weeks prior to first concrete placement. Data for each mix shall include the following:

a. Mix identification number (unique for each mix submitted).

b. Statement of intended mix use.
c. Mixture proportions.
d. Water/cementitious materials ratio.
e. Wet and dry unit weight.
f. Total air content.
g. Design slump and allowable range after additions of all admixtures.
h. Compressive strength tests.

3. Shrinkage testing per ASTM C 157.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Show all reinforcing, top and bottom profile of concrete element, supports below, including beams, columns and walls, grade beams, concrete walls, joists, etc. framing into element.
2. Provide one continuous elevation at 1/4" (1:48) scale for all beams, joists or walls in a continuous line. Show pockets and openings in shear walls, structural slabs, beams, elevations of top of beams, walls, columns, sections through beams, pilasters, columns, and placing sequence of reinforcing for items with more than one reinforcing layer.
3. Show locations of approved construction joints, locations of pour strips, splices of reinforcing, type of splice used and splice location. Identify all ASTM A706 and epoxy coated reinforcing locations.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of Architect.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Curing compounds.
7. Bonding agents.
8. Vapor retarders.
9. Repair materials.

B. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates: Submit test reports indicating that aggregates are not potentially reactive based on the ASTM C295 or ASTM 1260 testing limits set forth in section 5.1 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association). Alternatively, submit ASTM C1567 test reports indicating that the combination of mix ingredients reduces the expansion due to Alkali aggregate reactivity such that the mix complies with section 5.2 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association). All tests for submitted reports shall have been performed within one year of the submittal date.

C. Minutes of preinstallation conference.

D. Placement Notification: Submit notification to Architect at least 24 hours in advance of placement.

E. Certification of chloride screen effectiveness for penetrating sealers.

F. Proposed location of saw cut joints not indicated on Drawings.

G. Curing compound data demonstrating specified moisture loss performance.

H. Evaporative retarder product and application data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
3. Personnel inspecting concrete reinforcing steel have current certification as an ACI Concrete Construction Inspector or have experience in concrete construction acceptable to the Architect.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

F. Formwork: Contractor shall be responsible for design and engineering of formwork. Design of formwork and preparation of formwork drawings shall be performed under supervision of a qualified engineer registered in the state of the project.

G. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

H. Preinstallation Conference: Conduct conference at Project site ~~[<Insert location>]~~.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

   a. Contractor's superintendent.
   b. Ready-mix concrete manufacturer.
   c. Concrete subcontractor.
   d. Special concrete finish subcontractor.
   e. Owner’s Testing/Inspection Agency.

2. Review as applicable to Project special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.
3. Minutes of the meeting shall be recorded by Contractor and distributed to all parties within five days. Provide one copy to Owner’s representative and Architect.

I. Record of Work: Maintain a record listing time and date of all structural concrete placement. Such record shall be kept until completion of Project and shall be available to Architect for examination at any time.

J. Pre-Placement Inspection: Formwork installation, reinforcing steel placement and installation of all items to be embedded or cast into concrete shall be verified by Contractor prior to placement.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement if present.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated, and edge sealed.
    c. Structural 1, B-B or better; mill oiled, and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled, and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties: Factory-fabricated, removable, or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 1/2" inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed, where welding of reinforcement or field bending is noted on Drawings.

D. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 ASTM A 706/A 706M for bars that may be field bent, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M for bars that are prefabricated, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

F. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain steel wire, with less than 2 percent damaged coating in each 12-inch wire length.

G. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

H. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I/II, gray. Alternate cementitious materials when proposed to control alkali-silica reactions and tested as part of a representative concrete mix in accordance with ASTM C1567, may be used subject to approval. Supplement with the following:

a. Fly Ash: ASTM C 618, Class F or C.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. All coarse and fine aggregate shall be tested per ASTM C 295 or ASTM C 1293 in accordance with section 5.1 of "Guide Specification for Concrete Subject to Alkali-Silica Reactions" (2007 Portland Cement Association).

1. Maximum Coarse-Aggregate Size: As indicated on Drawings.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.

3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
c. Euclid Chemical Company (The), an RPM company; ARRMATECT, EUCON BCN, or EUCON CIA.
d. Grace Construction Products, W. R. Grace & Co.; DCI.
e. Sika Corporation; Sika CNI.

C. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
    b. Cortec Corporation; MCI- 2000 or 2005NS.
    c. Grace Construction Products, W. R. Grace & Co.; DCI-S.
    d. Sika Corporation; FerroGard 901.

2.6 FIBER REINFORCEMENT

A. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 2-1/4 inches.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
    b. BASF Construction Chemicals - Building Systems; Confilm.
    c. ChemMasters; SprayFilm.
    d. Conspec by Dayton Superior; Aquafilm.
    e. Dayton Superior Corporation; Sure Film (J-74).
    f. Edoco by Dayton Superior; BurkeFilm.
    g. Euclid Chemical Company (The), an RPM company; Eucobar.
    h. Kaufman Products, Inc.; Vapor-Aid.
    i. Lambert Corporation; LAMBCO Skin.
    j. L&M Construction Chemicals, Inc.; E-CON.
    k. Meadows, W. R., Inc.; EVAPRE.
    l. Metalcrete Industries; Waterhold.
    m. Nox-Crete Products Group; MONOFILM.
    n. Sika Corporation; SikaFilm.
    o. SpecChem, LLC; Spec Film.
    p. Symons by Dayton Superior; Finishing Aid.
    q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
    r. Unitex; PRO-FILM.
    s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Film must chemically break down in a four to six-week period. Provide data from independent laboratory indicating maximum moisture less than 0.30 kg/m^2 at 72 hours when tested in accordance with ASTM C 156.

F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A. Shall have test data from an independent laboratory indicating a maximum moisture less than 0.30 kg/m^2 at 72 hours when tested in accordance with ASTM C 156.

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.9 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than [5000 psi (34.5 MPa)] <Insert strength> at 28 days when tested according to ASTM C 109/C 109M.

2.10 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 for post-tensioned concrete, 0.15 for reinforced concrete exposed to chlorides in service, 0.30 for other reinforced concrete, and 1.00 for reinforced concrete that will be dry and protected from moisture in service, percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Performance and Design Requirements:

1. Shrinkage: Shrinkage strain, determined in accordance with ASTM C 157 as amended and modified herein, shall not exceed the values below for each concrete class:

a. Amendments and modifications to ASTM C 157:

1) Storage: After initial 24-hour comparator reading, specimens are placed back in lime saturated water until age of seven days. At seven days another comparator reading is taken. This reading is used as the base reading which is used to calculate percent shrinkage. The specimens are stored at 50% humidity and 73° F.
2) Test Reports: Report gage length (average of three) after 4, 7, 14, 28, and 56 days. In addition to the information required by ASTM C 157, Section 11, shrinkage test reports shall include gage lengths (initial length measurements) used to determine reported shrinkage strains.

b. 28 Day Shrinkage Strain: Shrinkage strains shall not exceed the following:

1) Concrete for slab-on-grade placed directly on vapor barrier: 0.046%.

2) Concrete for bearing walls (basement walls excluded) and/or columns : 0.046%.

2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion structural normal-weight concrete mixture as noted on Drawings, unless aggregates are “potentially reactive” with alkalis based on the ASTM C 295 or ASTM C 1260 or ASTM C 1293 testing limits of Section 5.1 of “Guide Specification of Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association). When aggregates are “potentially reactive”, compliance with Section 5.2 of “Guide Specification for Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association) must be established through ASTM C 1567 testing for proposed alternate concrete mixture. Submit test reports in accordance with Part I of this Specification.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M and furnish batch ticket information.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117. Concrete adjacent to elevator hoistway shall be installed to tolerances required by elevator manufacturer.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.
3. The permissible irregularity is a cumulative value due to all sources including layout, plumbness, member size, formwork offsets, joints, and member levelness. The permissible irregularity shall also apply between adjacent concrete surfaces on opposite sides of construction joint, expansion joint or shrinkage pour strip if present.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

L. Protect void form from moisture at all times before concrete placement.

M. Voids: Provide voids of full-size and extent shown on Drawings. Specified void form may be used at the Contractor’s option. Where void forms are used below structural slab-at-grade, place 1/8-inch minimum thick masonite or plywood sheet on top of void form. Prevent concrete from entering void space.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."

a. Tolerance of Embedded Items: Comply with ACI 117.

1) Anchor Rods:
a) Plumbness: Within +/- 1/16 inch (2 mm) over anchor rod projection.

2) Embedded Plates and Weldments:
   a) Location: +/- 1 inch (25 mm) vertical, +/- 1 inch (25 mm) ~~[2 inches (51 mm)]~~ horizontal.
   b) Plumb and Alignment: 1/4 inch in 12 inches (1:48).

2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated. Where masonry or veneer intersects concrete, provide one vertical dovetail slot for each 8 inches (200 mm) of masonry thickness. Where concrete serves as the backup, space slots at 16 inches (400 mm) on center.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
3. Leave formwork and shoring in place a minimum of 15 days after concrete placement unless reshoring is used.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

D. Reshoring:

1. If formwork and shoring are removed before concrete is 15 days old, reshoring shall remain in place a minimum of 15 days after placement irrespective of concrete strength.
2. For multi-story construction, reshoring shall remain in place a minimum of 15 days after placing of concrete deck above irrespective of concrete strength.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Size, length, number, and placement of supports shall be sufficient as to maintain reinforcing position within specified tolerances during construction traffic and concrete placement.

E. On vertical formwork, use approved bar chairs or spacers as required to maintain concrete cover and bar position. Do not staple or use any other metallic fastener to secure bolsters, chairs, etc. to formwork for concrete surfaces exposed to exterior.

F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

G. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

H. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside pilasters integral with walls, near corners, and in concealed locations where possible. Locate at centerline of support or middle third of span.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
3. Interior Slabs-on-Grade to Receive Carpet or Wood Floor Covering: Construct slabs as large a placement area as practical. Unless noted otherwise on Drawings, locate construction joints on column centerlines. Provide control joints at column centerlines and at intervals not more than 30 feet each way.
4. All Other Interior Slabs-on-Grade: Unless noted otherwise on Drawings, locate construction joints on column centerlines. Locate control joints where shown on Drawings. If not shown, provide control joints at column centerlines and at intervals not more than 10 feet each way.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch (12 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Joints in Slabs-on-Metal Deck: Locate construction joins as shown on Drawings. For slabs with welded wire reinforcing, continue reinforcing through construction joint and lap in

adjacent pour. For slabs without welded wire reinforcing, provide #4 bar 4 feet in length spaced at 12 inches on center staggered along the joint. Do not provide control joints.

F. Topping Slabs Exposed to View: Locate control joints where shown on the Contract Drawings. If not shown, locate topping slab control joints at column centerlines, over girders and at intervals not more than 10 feet each way.

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   a. Slabs supported by metal deck shall be gaged to provide the specified slab thickness over beams.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view otherwise indicated.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

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

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.

1. Apply scratch finish to surfaces to receive concrete floor toppings.

2. Location: roof over Server room.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated exposed to view or to be covered with resilient flooring, carpet, ceramic, or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
   b. Specified overall values of flatness, F(F) 30; and no limit for levelness, F(L); with minimum local values of flatness, F(F) 24; and of no limit for levelness, F(L); for suspended slabs supported by metal deck.

E. Broom Finish: Apply a broom finish to interior concrete landings platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.11 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb./sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Moisture-retaining-cover shall be inspected each day by Contractor. Any areas which do not show condensation on underside of cover or any slab areas which are not wet shall be immediately rewetted and cover replaced to prevent moisture loss.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning and that are unacceptable to Architect. Allow Architect and Structural Engineer to observe concrete surfaces upon removal of forms and prior to repair of surface defects. Defects in structural concrete shall be brought to the attention of the Architect and Structural Engineer.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template. Submit proposed repair to Architect for review prior to commencement of work.

1. Repair finished surfaces containing defects that are unacceptable to Architect. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.13 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

3.14 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

SECTION 042010 – REINFORCED UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Miscellaneous masonry accessories.

B. Related Sections:
1. Section 055000 "Metal Fabrications" for furnishing steel shelf angles, anchor rods, and bearing plates for unit masonry.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Unit Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide reinforced unit masonry that develops indicated net-area compressive strengths at 28 days, as indicated on drawings.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Contractor will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense. Materials tested shall be the

same in every way to the materials used to construct this project and shall be from the same lots or batches used for constructing this project.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
2. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.6 ACTION SUBMITTALS

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

B. Shop Drawings: For the following:

1. Reinforcing Steel: Detail bending and placement of reinforced unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls. Drawings shall include:

    a. 1/4” scale elevations of all walls with all openings and reinforcing shown.
    b. Top and bottom elevations of walls and bearing elevations of all elements supported.
    c. Size and location of all openings, pockets, embedments, and anchor bolts.
    d. Bar sizes, location, and quantities of reinforcing steel.
    e. Location and arrangement of supporting and spacing devices.
    f. Bending and cutting schedules.
    g. All control joints, expansion joints and horizontal relief joints.
    h. All other framing and/or special conditions affecting the work.

1.7 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.

    a. Include material test reports substantiating compliance with requirements.
    b. Include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Grout: Submit grout strength test data. Data shall be in conformance with the requirements for concrete mix designs per Division 3 section “Cast-in-place concrete”
    a. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
    b. For self consolidating grout, include test reports for slump flow and visual stability index (VSI) as determined by ASTM C1611

C. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in TMS 602/ACI 530.1/ASCE 6.

1.8 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

C. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 latest edition unless modified by requirements in the Contract Documents.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as required to meet the specified prism strength, but in no case shall units be less than 1900 psi.
2. Density Classification: Lightweight unless otherwise indicated.

2.2 MASONRY LINTELS

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure prefabricated lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

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

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.

E. Aggregate for Grout: ASTM C 404.

F. Water: Potable.

G. Additives: None permitted, except as specified herein. Specifically, do not lower freezing point of mortar or grout by use of calcium chloride or other antifreeze agents.

2.4 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Wire Size for Side Rods: As indicated on drawings
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.5 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed steel bolts complying with ASTM F1554 grade 36, or ASTM A307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.6 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. For reinforced masonry, use portland cement-lime mortar.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Reinforced Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. Mix cementitious materials and aggregates between 3 and 5 minutes in a mechanical batch mixer with a sufficient amount of water to produce a workable consistency. Unless acceptable, do not hand mix mortar. Maintain workability of mortar by remixing or retempering. Discard mortar which has begun to stiffen or is not used within 2-½ hours after initial mixing.

D. Grout for Reinforced Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 7 in TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Grout shall attain a minimum compressive strength of 2000 psi at 28 days when tested in accordance with C1019.
3. Except for self-consolidating grout, mix and proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated.
4. Provide grout with a slump of 8 to 11 inches for grout heights less than 5 feet 4 inches, or 10 to 11 inches for grout lift heights greater than 5 feet 4 inches as measured according to ASTM C 143/C 143M, unless self-consolidating grout is used.
5. Self consolidating grout, if used, shall comply with the material requirements of ASTM C476; have a slump flow of 24 to 30 in as determined by ASTM C1611/C1611M; and has a Visual Stability Index (VSI) less than or equal to 1 as determined in accordance with ASTM C1611/C1611M, Appendix X.1.
6. Proportioning of self-consolidating grout at the project site is not permitted. Do not add water at the project site except in accordance with the self-consolidating grout manufacturer's recommendations.
7. Do not use admixtures unless acceptable. Field additional of admixtures is not permitted in self-consolidating grout.

PART 3 - EXECUTION

3.1 LAYING MASONRY WALLS

A. Bond Pattern: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

B. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

C. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.2 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar each side of grouted cells.

3.3 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.4 CONTROL AND EXPANSION JOINTS

A. General: Install control joint materials in reinforced unit masonry as masonry progresses, as indicated on drawings.

3.5 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

3.6 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6, latest edition.

1. Support reinforcement to prevent displacement caused by construction loads or by placement of grout or mortar, beyond the allowable tolerances.
2. Completely embed reinforcing bars in grout.
3. Maintain clear distance between reinforcing bars and the interior of masonry unit or formed surface of at least 1/4 inch for fine grout and 1/2 inch for coarse grout, except where cross webs of hollow units are used as supports for horizontal reinforcement.
4. Place reinforcing bars maintaining the following minimum cover:

    a. Masonry face exposed to earth or weather: 2 inches for bars larger than No. 5; 1½ inches for No. 5 bars or smaller.
    b. Masonry not exposed to earth or weather: 1½ inches.

5. Maintain minimum clear distance between parallel bars of the nominal bar size or 1 inch, whichever is greater.
6. In columns and pilasters, maintain minimum clear distance between vertical bars of one and one-half times the nominal bar size or 1½ inches whichever is greater.
7. Splice only where indicated on the Project Drawings, unless otherwise acceptable.
8. Unless accepted by the Architect/Engineer, do not bend reinforcement after it is embedded in grout or mortar.
9. Noncontact lap splices: Position bars spliced by noncontact lap splice no farther apart transversely than one-fifth the specified length of lap nor more than 8 inches
10. Joint reinforcement

    a. Place joint reinforcement so that longitudinal wires are embedded in mortar with a minimum cover of 1/2 inch when not exposed to weather or earth; or 5/8 inch when exposed to weather or earth.
    b. Provide minimum 6-inch lap splices for joint reinforcement.
    c. Ensure that all ends of longitudinal wires of joint reinforcement at laps are embedded in mortar or grout.

11. Placement Tolerances

    a. Place reinforcing bars in walls and flexural elements within a tolerance of 1/2 inch.
    b. Place vertical bars within:

        1) 2 inches of the required location along the length of the wall when the wall segment length exceeds 24 inches.
        2) 1 inch of the required location along the length of the wall when the wall segment length does not exceed 24 inches

    c. If it is necessary to move bars more than one bar diameter or a distance exceeding the tolerance stated above to avoid interference with other reinforcing steel, conduits, or embedded items, notify the Architect/Engineer for acceptance of the resulting arrangement of bars.
    d. Foundation dowels that interfere with unit webs are permitted to be bent to a maximum of 1 inch horizontally for every 6 inches of vertical height.

C. Cleanouts: Provide cleanouts in the bottom course of masonry for each grout pour when the grout pour height exceeds 5 feet 4 inches.

1. Construct cleanouts so that the space to be grouted can be cleaned and inspected. In solid grouted masonry, space cleanouts horizontally a maximum of 32 inches on center.
2. Construct cleanouts with an opening of sufficient size to permit removal of debris. The minimum opening dimension shall be 3 inches.
3. After cleaning, close cleanouts with closures braced to resist grout pressure.

D. Grout Placement

1. Placing time: Place grout within 1-1/2 hours from introducing water in the mixture and prior to initial set.

    a. Discard site-mixed grout that does not meet the specified slump without adding water after initial mixing.
    b. For ready-mixed grout:

        1) Addition of water is permitted at the time of discharge to adjust slump.
        2) Discard ready-mixed grout that does not meet the specified slump without adding water, other than the water that was added at the time of discharge. The time limitation is waived as long as the ready-mixed grout meets the specified slump.

2. Confinement: Confine grout to the areas indicated on the Project Drawings. Use material to confine grout that permits bond between masonry units and mortar.
3. Grout pour height:

    a. Definition: The total height of masonry to be grouted prior to erection of additional masonry. A grout pour consists of one or more grout lifts.
    b. Do not exceed the maximum grout pour height given in TMS 602/ACI 530.1/ASCE 6, Table 7.

4. Grout lift height:

    a. Definition: An increment of grout height within a total grout pour. A grout pour consists of one or more grout lifts.
    b. For grout except self-consolidating grout:

        1) Where the following conditions are met, place grout in lifts not exceeding 12 feet 8 inches.

            a) The masonry has cured for at least 4 hours.
            b) The grout slump is maintained between 10 and 11 inches.
            c) No intermediate reinforced bond beams are placed between the top and the bottom of the pour height.

        2) When there are intermediate bond beams within the grout pour, limit the grout lift height to the bottom of the lowest bond beam that is more than 5 feet 4 inches (1.63 m) above the bottom of the lift, but do not exceed a grout lift height of 12 feet 8 inches.
        3) When the conditions above are not met, place grout in lifts not exceeding 5 feet 4 inches.

5. For self-consolidating grout:

    a. When placed in masonry that has cured for at least 4 hours, place in lifts not exceeding the grout pour height.
    b. When placed in masonry that has not cured for at least 4 hours, place in lifts not exceeding 5 feet 4 inches.

E. Consolidation

1. Consolidate grout at the time of placement.

    a. Consolidate grout pours 12 inches or less in height by mechanical vibration or by puddling.
    b. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.
    c. Consolidation or reconsolidation is not required for self-consolidating grout.

F. Grout key: When grouting, form grout keys between grout pours. Form grout keys between grout lifts when the first lift is permitted to set prior to placement of the subsequent lift

1. Form a grout key by terminating the grout a minimum of 1½ inches below a mortar joint.
2. Do not form grout keys within beams.
3. At beams or lintels laid with closed bottom units, terminate the grout pour at the bottom of the beam or lintel without forming a grout key.

END OF SECTION 042010

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

B. Related Sections:

1. Section 014000 "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Section 053100 "Steel Decking" for field installation of shear connectors through deck.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.4 PERFORMANCE REQUIREMENTS

A. Connections
1. Provide connections as shown or noted on Drawings. Design of connections not shown or noted shall be provided by Structural Engineer-of-Record upon request.

1.5 ACTION SUBMITTALS

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

B. Shop and Erection Drawings: Show location, fabrication, and assembly of structural-steel components.

1. Location of each piece or detail within the structure.
2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
3. Include embedment piece and setting drawings.

4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
6. Reproduction of Contract Documents is not permitted.
7. Provide schedule for submittal of shop and erection drawings.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and fabricator

B. Welding certificates.

C. Mill test reports for structural steel, including chemical and physical properties.

D. Product Test Reports: For the following if present on project:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.
6. Nonshrink grout.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303 as amended below:
   a. Section 3.2: Replace entire section with the following: “Requirements for structural steel including quantities, sizes, locations, arrangement, and details shall be shown or noted in the overall Contract Drawing package. Fabricator is responsible for incorporating all such information from structural, architectural, mechanical, and electrical drawings, as well as those of other disciplines.”

b. Section 3.5: Remove all text after first sentence.
c. Section 3.6: Replace entire section with the following: “When the fast-track project delivery system is selected; release of structural drawings shall constitute release for construction only if specifically noted as such on the drawing. Drawing indicated “preliminary” or “not for construction” shall not be used for detailing or construction except where the risk of any cost or delay associated with subsequent revisions to Contract Documents is accepted by the Owner, Contractor or Fabricator.”
d. Section 4.4: Revise second sentence to read the following: “The shop and erection drawings shall be returned in accordance with the schedule defined in Division 1 of the project Specification. In the absence of such schedule, the Owner’s Designated Representative for Design shall return submittals within 14 calendar days of receipt from the Owner’s Designated Representative for Construction.”

2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.9 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. W-Shapes: ASTM A 992/A 992M unless indicated otherwise on Drawings.

C. Channels, Angles Shapes: ASTM A 36/A 36M unless indicated otherwise on Drawings.

D. Plate and Bar: ASTM A 36/A 36M unless indicated otherwise on Drawings.

E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade **C**, structural tubing.

F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: as indicated on Drawings.
2. Finish: Black except where indicated to be galvanized.

G. Welding Electrodes: Comply with AWS requirements, 70 Series

1. Conform to Charpy V-Notch test requirements of AISC 360.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. Use Tension-Control, High-Strength Bolt-Nut-Washer Assemblies whenever possible unless indicated otherwise.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain

D. Steel Headed Stud Anchors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable

1. Configuration: Straight
2. Nuts: ASTM A 563 heavy-hex carbon steel.
3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436, Type 1, hardened carbon steel.
5. Finish: Plain

F. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436, Type 1, hardened carbon steel.
4. Finish: Plain.

G. Threaded Rods: ASTM A 36/A 36M.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Plain.

H. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

K. Deformed Anchor Studs (DAS) / Deformed Bar Anchors (DBA): Made from ASTM A 108 low carbon steel, cold worked and deformed per ASTM A 496. Minimum yield stress = 60 ksi (415 MPa); minimum tensile strength = 80 ksi (550 MPa).

L. Rebar: Rebar used for welding shall meet the requirements of ASTM A-706. Minimum bend diameters per ACI 318.

M. Expansion Anchors, Screw Anchors, and Adhesive Anchors: Size and Manufacturer as indicated on Drawings. Complete assemblies with required rods, nuts, washers, and adhesive system as applicable. Installed in accordance with Manufacturer's installation instructions. Current ICC approval and published ICC Research Report required.
1. Finish for use in conditioned environments free from potential moisture (interior): Plain or in accordance with Manufacturer's standard.
2. Finish for use in exposed or potentially wet environments and for attachment of exterior cladding materials: Galvanized in conformance with ASTM A 153 or stainless steel, Series 300.

2.3 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength = 6000 psi. Required where grout is exposed to view or weathering.

2.4 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces. Do not enlarge bolt holes by burning.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning or SSPC-SP 3, "Power Tool Cleaning."

F. Steel Headed Stud Anchors and Deformed Anchor Studs / Deformed Bar Anchors: Prepare steel surfaces as recommended by manufacturer of anchors. Use automatic end welding of headed-stud shear connectors anchors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

H. Splices: Splicing of members to obtain required lengths is not permitted without prior approval of structural Engineer-of-Record unless indicated on the Drawings.

I. Substitutions: Where exact sizes and weights indicated on Drawings are not readily available, secure approval of alternate sizes from Structural Engineer-of Record in time to prevent project delay.

2.5 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.6 SOURCE QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

2. Do not apply permanent loading other than the weight to supported concrete slab-on-deck assemblies to composite beams and girders until concrete has achieve 75 percent of its design strength without prior approval of structural Engineer-of-Record.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate where indicated on Drawings.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Clean and moisten surfaces to receive grout. Immediately remove any remaining free water. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

E. Splice members only where indicated.

1. Fasten splices in compression after bearing surface have been brought into contact. Close all gaps greater than 1/16" by driving non-tapered mild steel shims full depth of bearing surface along full length of gap.

F. Do not use thermal cutting during erection unless approved by Structural Engineer-of-Record. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Steel Headed Stud Anchors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated on Drawings.

3.5 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

B. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting."

END OF SECTION 051200

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Cordeck.
6. DACS, Inc.
7. Epic Metals Corporation.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
10. Nucor Corp.; Vulcraft Group.
11. Roof Deck, Inc.
12. Verco Manufacturing Co.
13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), grade, thickness and profile as indicated, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard baked-on, rust-inhibitive primer.
2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated, G60 (Z180) zinc coating. May be used at interior or exterior locations not indicated to be painted and exposed to view.
3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), grade, thickness and profile as indicated, G60 (Z180) zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard baked-on, rust-inhibitive primer. Use at exterior locations indicated to be painted and exposed to view.
4. Span Condition: As indicated.

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated but not less than recommended by SDI Publication No. 31 for overhang and slab depth.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747-inch-thick, with factory-punched hole of 3/8-inch minimum diameter.

H. Galvanizing Repair Paint: ASTM A 780

I. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. When steel headed stud anchors are to be welded through metal deck and/or corrugated metal forming, the top flange of beams to receive such anchors shall be unpainted and free of debris prior to installation of the deck and/or forming.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations. Obtain prior written approval from Structural Engineer-of-Record before installing shoring.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

1. Refer to Drawings for opening sizes requiring reinforcement and typical reinforcement options.
2. Miscellaneous openings not shown on the Drawings such as those required for vents, risers, conduits, etc. shall be cut and reinforced if necessary, by the trade requiring the opening.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck with prior written approval of Structural Engineer-of-Record. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: As indicated, nominal.
2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart. Steel headed stud anchors may be substituted for welds one for one in meeting spacing requirements.
3. Weld Washers: Install weld washers at each weld location when the minimum uncoated steel thickness is less than 0.028 inches.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows unless otherwise indicated:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing as indicated, with end joints as follows:

1. End Joints: As indicated.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Install piercing hanger tabs at minimum spacing indicated in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

G. Fastening Corrugated Metal Forming: Secure to supporting member with 1/2-inch minimum diameter fusion welds made through 0.0747-inch welding washers. Minimum weld requirements as follows:
1. End Laps: In valley of side laps and at center of sheet.
2. Intermediate Supports: In valley of side lap on every other support and in valley of center corrugation on the remaining supports (to form an X pattern).
3. Exterior Edges: 12” on center.
4. Minimum Number of Welds Per 100 square foot of Deck Area:
    a. 0.0164 inches thick and thinner – 25
    b. Thicker than 0.0164 inches – 15

H. Steel headed stud anchors shall be field welded to the structural members only after all steel framing, deck and/or forms are in place and shored when required. Deck and/or forming shall be installed such that the bottom rib plate is in continuous contact with the surface to receive anchors.

I. Steel Headed Stud Anchor Capacity: Number of steel headed stud anchors indicated on Drawings is based on the allowable capacity for anchors in normal weight or light weight concrete as listed in AISC 360 for the composite deck specified. If additional anchors are required due to decreases in anchor capacity for the type of deck and stud placement supplied, such additional anchors shall be provided at no additional cost to the Owner.

J. Steel Headed Stud Anchor Installation:
1. Install anchors in accordance with Manufacturer's instructions. Use only personnel and equipment authorized by the Manufacturer.
2. Use through-deck anchor welding where deck material thickness permits proper weld fusion to develop required anchor capacity. Provide adequate test results to verify feasibility of through-deck welding for the particular anchor sizes and deck thicknesses involved.
3. If through-deck anchor welding is not feasible, install anchors through pre-punched holes in deck. Provide pre-punched holes only where required for anchor installation and keep hole oversize to minimum required to develop a proper weld.

K. At the beginning of each shift of work, and after each time welding equipment has been moved, two test anchors shall be installed and bent to 45 degrees by the Contractor. If failure occurs, adjust equipment and repeat test. Two consecutive test studs shall be welded and found satisfactory before production for that shift begins or is resumed.

3.4 FIELD QUALITY CONTROL

A. Testing and Inspection: As indicated on Drawings.

3.5 PROTECTION

A. Galvanizing Repairs: Where deck is exposed to weather or moisture, prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

1. Do not use deck units for storage or as a working platform until permanently secured in position.
2. Contractor shall assure that completed deck is not damaged by use as a runaway, storage of materials or subsequent work.
3. Contractor shall assure that construction loads are not allowed which exceed the safe carrying capacity of the deck.

END OF SECTION 053100

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes metal fabrications and includes, but is not limited to, the following types of fabrications:

1. Loose bearing and leveling plates.
2. Miscellaneous framing and supports.
3. CMU partition head supports.

1.2 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: Submit product data for the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Submit shop drawings detailing the fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1. For installed products indicated to comply with design loads, include structural analysis data, for information only, signed and sealed by the qualified professional engineer responsible for their preparation.
2. Include plans and elevations at not less than 1" to 1'-0" scale and include details of sections and connections at not less than 3" to 1'-0" scale.

1.4 QUALITY ASSURANCE

A. Fabricator/Installer Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project for a minimum of 5 years, with a record of successful in-service performance, with sufficient production capacity to produce required units without causing delay in the work.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code--Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code--Sheet Steel."
3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store metal fabrications in a dry, well-ventilated, weathertight place. Deliver and handle so as to prevent any type of damage to the fabricated work.

1.6 FIELD CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Exterior Metal Fabrications: All exterior metal fabrications shall be fabricated and installed to prevent buckling, opening up of joints and overstressing of welds and fasteners under the following temperature conditions:

1. Base fabrication on a temperature of +70 deg F at time of installation with allowance made for an exposed metal surface temperature range of -5 deg F to +180 deg F. Make all necessary adjustments and provisions for concealed expansion.

2.2 METALS, GENERAL

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Cold Finished Steel Bars: ASTM A 108, grade as selected by fabricator.

C. Slotted Channel Framing: Cold-formed metal channels with continuous slot and with flanged edges returned toward web complying with MFMA-4 and fabricated from steel complying with ASTM A 1011/A 1011M. Width, depth, and metal thickness as required to suit performance requirements.

D. Malleable-Iron Castings: ASTM A 47, Grade 32510.

E. Gray-Iron Castings: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.

F. Cast-in-Place Anchors in Concrete: Anchor channel type, with filler strips, manufactured from formed hot or cold rolled carbon steel channels with flange edges returned toward web, having a minimum of 2 stud, or I, anchors shop welded to the back of each channel, complying with ASTM A 1011. Provide channels, bolts, washers, and shims hot-dip galvanized per ASTM A 153/A 153M. Width, depth, and metal thickness as required to suit performance requirements.

G. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.4 PAINT

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

1. 94-258 Series Multi-Prime Fast Dry 2.8 VOC Universal Metal Primer; Pittsburgh Paints.

2. B50AZ6 Kem Kromik Universal Metal Primer; Sherwin-Williams Co.
3. Series 37H Phenolic Alkyd Primer Chem-Prime; Tnemec.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FASTENERS

A. Anchor Bolts: ASTM F 1554, Grade 36.

B. Eyebolts: ASTM A 489.

C. Machine Screws: ASME B18.6.3.

D. Lag Bolts: ASME B18.2.1.

E. Wood Screws: Flat head, carbon steel, ASME B18.6.1.

F. Plain Washers: Round, carbon steel, ASME B18.22.1.

G. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Interior Expansion Anchor Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

I. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.6 GROUT

A. Non-shrink, Non-metallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.7 CONCRETE FILL

A. Concrete Materials and Properties: Composed of ASTM C 150 Type I Portland cement, ASTM C 33 sand and coarse aggregates and potable water to produce a low slump mix suitable for placement. Grade coarse aggregate from 1/8 inch with at least 95 percent passing a 3/8-inch sieve and not more than 10 percent passing a No. 8 sieve. Fill shall be proportioned to provide a minimum 28-day compressive strength of 3000 psi.

2.8 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

1. Welded connections may be used where bolted connections are shown.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Weld corners and seams continuously along entire line of contact to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated, coordinate with supporting structure. Fabricate and space anchoring devices and fasteners to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

I. Remove sharp or rough areas on exposed traffic surfaces.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous. Make up threaded connections tight so that threads are entirely concealed.

2.9 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize exterior plates after fabrication, prime paint interior plates after fabrication.

2.10 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports indicated and as necessary to complete the Work and which are not a part of the structural framework, including but not limited to framing and supports for CMU partition head supports, cooling tower dunnage.

B. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

C. CMU Partition Head Supports: Fabricate supports from 4 inch by 4 inch by 1/4 inch by 36-inch-long structural steel angles. Drill supports a maximum of 12 inches o.c. to receive expansion bolts.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches from each end, 6 inches from corners, and 24 inches o.c., unless otherwise indicated.

2.12 PIPE BOLLARDS

A. Fabricate pipe bollards from Schedule 40 steel pipe.

B. Fabricate bollards with 3/8 inch thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4 inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

2.13 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.14 STEEL AND IRON FINISHES

A. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces by removing oil, grease, and similar contaminants in accordance with SSPC-SP 1 "Solvent Cleaning," followed with the SSPC surface-preparation specifications listed below and environmental exposure conditions of installed metal fabrications. Surface preparation shall be done after fabrication and immediately prior to shop painting. Apply shop coat of paint within 4 hours after cleaning and before rust bloom occurs.

1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

B. Apply a minimum of one coat of shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be field welded, and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Dry Film Thickness of Primer: 2.5 to 3.0 mils, dry film thickness. Apply paint thoroughly and evenly to dry surfaces, free from holidays and pinholes, in accordance with manufacturer's directions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors. Drill holes for bolts to the exact diameter of the bolt. Provide screws threaded full length to the screw head.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Quality of Workmanship:

    a. At concealed connections: No improvement from mill finish, except preparation necessary for priming is required. Welds are not required to be ground.
    b. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness, pits, mill marks, nicks, or scratches shows after finishing and contour of welded surface matches that of adjacent surface. Defects and distortions shall not be visible to the eye nor show through painted or polished surfaces.

3.2 SETTING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use non-shrink grout, either metallic or non-metallic, in concealed locations where not exposed to moisture; use non-shrink, non-metallic grout in exposed locations, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.

B. CMU Partition Head Supports: Unless otherwise indicated place, partition head supports on alternate faces of CMU partitions every 6'-0" o.c. and expansion bolt to underside of structure. Do not bolt to CMU partitions.

3.4 INSTALLING PIPE BOLLARDS

A. Anchor bollards to existing construction with post-installed anchors and bolts. Provide four 3/4 inch anchors at each bollard, unless otherwise indicated. Embed anchors at least 4 inches in existing concrete.

B. Fill bollards solidly with concrete, mounding top surface.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0 mil dry film thickness.

END OF SECTION 05 50 00

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes miscellaneous carpentry.

1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for each type of process and factory-fabricated product indicated.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that materials comply with requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels; for lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 "American Softwood Lumber Standard" and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.
4. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

B. Wood Panels:

1. Plywood: Comply with DOC PS 1 "Construction and Industrial Plywood" for plywood panels. Use exterior grade for panels in wet conditions.

2. Thickness: As needed to comply with requirements specified but not less than thickness indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Provide chemical fire-retardant process tested and labeled by UL with flame spread and smoke developed ratings of 25 or less. Comply with performance requirements in AWPA U1, Use Category UCFA as a minimum for pressure treatment. Size wood before treatment so that minimum cutting will be required after treatment. Kiln dry lumber to a maximum 19 percent moisture content, kiln dry plywood to a maximum 15 percent moisture content, after treatment. Treat indicated items and the following:

1. Wood members required to be treated by Building Code having jurisdiction at the site and wood members specified as fire-retardant-treated.

B. Identify fire-retardant-treated wood with appropriate classification marking of UL.

2.3 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber for support or attachment of other construction, including blocking, nailers, and similar members.

B. For concealed boards, provide lumber with 19 percent maximum moisture content and the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.
2. Western Woods; WCLIB or WWPA, No. 2 Grade.

2.4 PANEL PRODUCTS

A. Telephone, Data, Security, and Electrical Equipment Backing Panels:

1. APA, Exposure 1, C-C Plugged, fire-retardant treated, manufactured with no added urea-formaldehyde, in thickness indicated or, if not indicated, not less than 3/4 inch thick.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

B. Power-Driven Fasteners: NES NER-272.

C. Nails, Wire, Brads, and Staples: Select material, type, size, and finish required for each use.

1. ASTM F 1667 for driven fasteners such as nails, spikes, and staples.
2. ASTM F 547 for nails used with wood and wood-based products.

D. Wood Screws: Select material, type, size, and finish required for each use. Comply with ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.

C. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 PANEL PRODUCT INSTALLATION

A. General: Comply with applicable recommendations contained in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial," and local utility requirements, if any, for plywood backing panels utilized as indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Countertop Underlayment: Bolt to miscellaneous steel framing.

2. Plywood Backing Panels: Secure to wall using proper fastening devices for substrates encountered spaced 12 inches on center maximum at perimeter 1/2 inch from corners and three rows of 3 fasteners each in the backerboard field. Countersink fasteners flush with plywood surface. Butt adjacent panels without lapping.

END OF SECTION 06 10 53

SECTION 07 18 00 - TRAFFIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes traffic coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show extent of each traffic coating. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.

C. Samples for Verification: For each type of traffic coating required, prepared on rigid backing and of same thickness and material indicated for the Work.

1. Provide stepped samples on backing large enough to illustrate build-up of traffic coatings.

1.3 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified independent testing agency indicating and interpreting test results for compliance of traffic coatings with requirements, based on comprehensive testing of current product formulations within the last three years.

B. Material Certificates: Signed by manufacturer certifying that traffic coatings comply with requirements, based on comprehensive testing of current product formulations within the last three years.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: To include in maintenance manuals specified in Division 01. Identify substrates and types of traffic coatings applied. Include recommendations for periodic inspections, cleaning, care, maintenance, and repair of traffic coatings.

1.5 QUALITY ASSURANCE

A. Installer (Applicator) Qualifications: An experienced applicator who has specialized in installing work similar in material, design, and extent to that indicated for this Project and who is certified by manufacturer.

1. Certification: Written approval or license of applicator by traffic coating manufacturer.

B. Source Limitations: As follows:

1. Use traffic coatings of a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels showing the following information:

1. Manufacturer's brand name.
2. Type of material.
3. Directions for storage.
4. Date of manufacture and shelf life.
5. Lot or batch number.
6. Mixing and application instructions.
7. Color.

B. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.

1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of the substrate.

1.8 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by traffic coating manufacturer agreeing to repair or replace traffic coatings that do not comply with requirements or that deteriorate during the specified warranty period. Warranty does not include deterioration or failure of traffic coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new substrate cracks exceeding 1/16 inch in width, fire, vandalism, or abuse by snowplow, maintenance equipment, and truck traffic.

1. Deterioration of traffic coatings includes, but is not limited to, the following:

a. Adhesive or cohesive failures.
b. Abrasion or tearing failures.
c. Surface crazing or spalling.
d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.

C. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Physical Requirements: Provide traffic coatings complying with ASTM C 957.

B. Material Compatibility: Provide primers; base, intermediate, and top coats; and miscellaneous materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.

C.

D. VOC Content: 100 g/L or less.

E. Low-Emitting Materials: Interior coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 TRAFFIC COATING TC01

A. Products: Subject to compliance with requirements, provide one of the following:

1. Basis of Design: Vulkem 350/950NF/950NF: Tremco

2. Advanced Polymer Technology Corp.
3. Dex-O-Tex/Crossfield Products Corp.
4. Gaco Western, Inc.
5. General Polymers.
6. Mameco International, Inc.
7. Neogard.
8. Pacific Polymers, Inc.
9. Poly-Carb Inc.
10. Sonneborn, Div. of ChemRex, Inc.
11. 3M Construction Markets.
12. Technical Barrier Systems.

B. Primer: Manufacturer's standard factory-formulated primer recommended for substrate and conditions indicated.

C. Preparatory and Base Coats: Single- or multicomponent aromatic liquid urethane elastomer.

D. Intermediate Coat: Single- or multicomponent aliphatic liquid urethane elastomer.

E. Top Coat: Single- or multicomponent aliphatic liquid urethane elastomer.

1. Color: As selected by Architect from manufacturer's full range.

F. Component Coat Thicknesses: As recommended by manufacturer for substrate and service conditions indicated, but not less than the following (measured excluding aggregate):

1. Base Coat: 25 mil min.
2. Intermediate Coat: 12 mill min.
3. Top Coat: 12 mill min.

G. Aggregate: Uniformly graded washed silica sand of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.

1. Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated, but not less than the following:

a. Intermediate Coat: To refusal.
b. Top Coat: As required to achieve slip-resistant finish.

2.3 MISCELLANEOUS MATERIALS

A. Joint Sealants: Single-component urethane sealant recommended in writing by manufacturer for substrate and joint conditions indicated and for compatibility with traffic coatings; complying with ASTM C 920, Grade NS for sloping and vertical applications or Grade P for deck applications, and Use T where subject to traffic or Use NT elsewhere.

B. Sheet Flashing: 60 mil minimum, nonstaining cured neoprene sheet.

C. Adhesive: Manufacturer's recommended contact adhesive.

D. Reinforcing Strip: Manufacturer's recommended fiberglass mesh.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Applicator present, for compliance with requirements and for other conditions affecting performance of traffic coatings.

1. Verify compatibility with and suitability of substrates.
2. Begin coating application only after minimum concrete curing and drying period recommended by traffic coating manufacturer has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.
3. Verify that substrates are visibly dry and free of moisture. Test for moisture by method recommended in writing by manufacturer.
4. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Clean and prepare substrates according to manufacturer's written recommendations to produce clean, dust-free, dry substrate for traffic coating application.

B. Mask adjoining surfaces not receiving traffic coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.

C. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.

1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
2. Remove concrete fins, ridges, and other projections.
3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.

4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

3.3 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.

B. Provide sealant cants at penetrations and at reinforced and nonreinforced deck-to-wall butt joints.

C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.

D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and traffic coating manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

3.5 TRAFFIC COATING APPLICATION

A. Apply traffic coating material according to ASTM C 1127 and manufacturer's written recommendations.

1. Start traffic coating application in presence of manufacturer's technical representative.
2. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft.
3. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated and omit aggregate on vertical surfaces.

B.

3.6 CURING AND PROTECTING

A. Cure traffic coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.

B. Protect traffic coatings from damage and wear during remainder of construction period.

END OF SECTION 07 18 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

1. Section Includes:

2. Mineral-wool blanket

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Low-emitting product certification.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing protocol required to achieve UL Classified rating. Identify products with appropriate markings of Underwriters Laboratories.

B. Formaldehyde-Free: Third Party Certified with UL Environmental Validation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET

A. Manufacturers: Subject to compliance with requirements, product products by one of the following:

1. CertainTeed Corporation
2. Johns Manville.
3. Knauf Insulation; EcoBatt Insulation with Ecose Technology.
4. Owens Corning.

B. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:

1. Free of Formaldehyde: Insulation manufactured with formaldehyde-free binder.
2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

C. Glass-Fiber Blanket, Reinforced-Foil Faced, INS-01: ASTM C 665, Type III , Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

2.2 INSULATION FASTENERS

A. Manufacturers: Subject to compliance with requirements, product products by one of the following:

1. AGM Industries, Inc.
2. Gemco.
3. Rodenhouse, Inc.

B. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

a. Ceiling plenums.

D. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings and seal each continuous area of insulation to ensure airtight installation.

a. Interior Walls: Set units with facing placed on room side.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb./cu. ft..

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 26 16 - UNDER-SLAB-ON-GRADE VAPOR RETARDER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes vapor retarder and installation accessories for installation under concrete slabs on grade.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete."

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site two weeks before start of installation of reinforced vapor retarders.

1. Review vapor-retarder installation, protection, and coordination with other work.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated including installation instructions.

1.4 INFORMATIONAL SUBMITTALS

A. Summary of test results per paragraph 9.3 of ASTM E 1745.

B. Manufacturer's installation instructions for placement, seaming and penetration repair instructions.

1.5 QUALITY ASSURANCE

A. Provide vapor retarder and accessories from a single source and single manufacturer. Provide accessories manufactured or approved by vapor retarder manufacturer for application indicated.

B. All mandatory ASTM E 1745 testing must be performed on a single production roll per ASTM E 1745 Section 8.1.

C. Coordination: Schedule work such that membrane will not be left exposed to weather for longer than that recommended by the manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature, and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Vapor retarder shall have all of the following qualities:

1. Maintain permeance of less than 0.01 Perms grains/(ft^2 · hr · inHg) as tested in accordance with mandatory conditioning tests per ASTM E 1745 Section 7.1 (7.1.1-7.1.5).
2. Other Performance Criteria:

    a. Strength: ASTM E 1745 Class A.
    b. Thickness: 15 mils minimum.

2.2 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
    b. Fortifiber Building Systems Group; Moistop Ultra 15.
    c. Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
    d. Reef Industries, Inc.; Griffolyn 15 mil Green.
    e. Stego Industries, LLC; Stego Wrap 15 mil Class A.

2.3 ACCESSORIES

A. Vapor Retarding Seam Tape:

1. Water Vapor Transmission Rate: 0.3 perms or lower per ASTM E 96.

B. Vapor Proofing Mastic:

1. Water Vapor Transmission Rate: 0.3 perms or lower per ASTM E 96.

C. Pipe Boots: Provide manufacturer's factory fabricated pipe boots. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas to receive vapor retarders. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

B. Ensure that subsoil is smooth, level and compacted with no sharp edges.

1. Level and compact base material.

C. Ensure that there is no moisture entrapment by vapor retarder due to rainfall or ground water intrusion.

3.2 INSTALLATION

A. Install vapor retarder in accordance ASTM E 1643 and manufacturer's written instructions.

1. Install vapor retarders continuously at locations under slab. Ensure there are no discontinuities in vapor retarder at seams or penetrations.
2. Unroll vapor retarder with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
3. Extend vapor retarder over footings and grade beams to a distance acceptable to the structural engineer or stop at impediments such as dowels and waterstops.
4. Seal vapor retarder to foundation wall, grade beam, or slab at an elevation consistent with the top of the slab or terminate at impediments such as waterstops or dowels.
5. Overlap joints 6 inches and seal with manufacturer's tape.
6. Apply tape to a clean and dry vapor barrier.
7. Seal all penetrations with manufactured or field-fabricated boots and with tape according to manufacturer's guidelines. Unsealed penetrations are not allowed.
8. Immediately repair damaged areas by cutting patches of vapor retarder, overlapping damaged area 6 inches and taping all sides with tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

3.3 PROTECTION

A. Protect vapor retarders from damage during installation of reinforcing steel and utilities and during placement of concrete slab.

END OF SECTION 07 26 16

SECTION 07 81 00 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cementitious sprayed fire-resistive materials.

1.2 DEFINITIONS

A. Sprayed fire-resistive material is applied to surfaces that are concealed from view behind other construction when the Work is completed or that are exposed to view in locations where they will not be physically abused meaning that the materials are not in contact with end user or end user's equipment causing dislocation or reduction in required thickness of material.

1.3 COORDINATION

A. Sequence and coordinate application of sprayed fire-resistive materials with other related work specified in other Sections to comply with the following requirements:

1. Provide temporary enclosures for interior applications to prevent deterioration of fire-resistive material due to exposure to unfavorable environmental conditions.
2. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
3. Do not apply fire-resistive material to metal roof deck substrates until concrete fill, if any, and roofing has been completed; prohibit roof traffic during application and drying of fire-resistive material.
4. Do not apply fire-resistive material to metal floor deck substrates until concrete fill has been completed.
5. Do not begin applying fire-resistive material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
6. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
7. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, tested and corrections have been made to defective applications.

1.4 ACTION SUBMITTALS

A. Product Data: Submit current edition of manufacturer's application and installation instruction manual and referenced bulletins.

B. Shop Drawings: Submit a "Fire-Resistive Materials Design Schedule Keyed to the Structural Drawings and Schedules" indicating the following:

1. Schedule for each building element receiving spray fire-resistive materials showing hourly rating and material thickness and UL Design Number.
2. When UL Designs are used for beams and columns smaller and larger than those listed in the UL Design, provide explanation of thickness adjustment based on W (weight per lineal foot)/D (perimeter of exposure) formulas for each element.
3. Locations and types of surface preparations required before applying sprayed fire-resistive material.
4. Extent of sprayed fire-resistive material for each construction and fire-resistance rating, including a schedule indicating the following:

    a. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
    b. Minimum thicknesses needed to achieve required fire-resistance ratings of structural components and assemblies.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer.

B. Product Certificates: For each type of fireproofing.

C. Evaluation Reports: For fireproofing, from ICC-ES.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer certified, licensed, or otherwise qualified by sprayed fire-resistive material manufacturer as having the necessary experience staff, and training to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its sprayed fire-resistive materials to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.

B. Fire-Test-Response Characteristics: Provide sprayed fire-resistive materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency acceptable to authorities having jurisdiction, for sprayed fire-resistive material serving as direct-applied protection tested per ASTM E 119.

2. Surface-Burning Characteristics: ASTM E 84.

C. Regulatory Requirements: Conform to the applicable building code requirements of the authorities having jurisdiction. Products, execution, and the thickness spray fire resistive materials shall conform to the applicable code requirements for the required fire resistance ratings.

1. UL Degree of Restraint: Unrestrained.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, shelf life if applicable, and fire-resistance ratings applicable to Project.

B. Use materials with limited shelf life within period indicated. Remove from Project site and discard materials whose shelf life has expired.

C. Store materials inside, under cover, aboveground, in a dry location, until ready for use. Remove from Project site and discard wet or deteriorated materials.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not apply sprayed fire-resistive material when ambient or substrate temperatures are 40 deg F or lower. When ambient or substrate temperatures are lower, provide temporary enclosures and heat to maintain temperatures at or above this level for 24 hours before and during application, and after application for a minimum of 24 hours or more, until the sprayed fire resistive material is cured.

B. Ventilation: Ventilate spaces during and after application of sprayed fire-resistive material. Provide a minimum of 4 air changes per hour until fire resistive material cures by the following:

1. Using natural means.
2. When natural means are inadequate, provide forced-air circulation at a rate of 4 air exchanges per hour.

1.9 WARRANTY

A. Special Warranty: Submit a written warranty, signed by Contractor and by Installer, agreeing to repair or replace sprayed fire-resistive materials that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Failures include, but are not limited to, cracking, flaking, or eroding by air or weather, in excess of specified requirements; peeling; and delaminating of sprayed fire-resistive materials from substrates due to defective materials and workmanship.
2. Not covered under the warranty are failures due to damage by occupants and Owner's maintenance personnel, exposure to environmental conditions other than those investigated and approved during fire-response testing, and other causes not reasonably foreseeable under conditions of normal use.

B. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SPRAYED FIRE-RESISTIVE MATERIALS

A. General: Provide manufacturer's standard products complying with requirements indicated for material composition and physical properties representative of installed products.

B. Subject to compliance with requirements, provide products by one of the following:

1. Cementitious (Gypsum) Sprayed Fire-Resistive Material for interior locations, concealed conditions, in buildings less than 75 ft. tall:

    a. Carboline Co., Fireproofing Products Div.; Pyrolite 15.
    b. GCP Applied Technologies (Grace, W. R. & Co., Construction Products Div.); Monokote Type MK-6.
    c. Isolatek International Corp., Cafco Products; Cafco 300.
    d. Southwest Fireproofing Products Co.; 5GP.
    e. Carboline Co., Fireproofing Products Div.; Pyrolite 22.
    f. GCP Applied Technologies (Grace, W. R. & Co., Construction Products Div.); Monokote Type Z-106.
    g. Isolatek International Corp., Cafco Products; Cafco 400.
    h. Southwest Fireproofing Products Co.; 7GP.

C. Material Composition: Cementitious sprayed fire-resistive material consisting of factory-mixed, dry formulation of gypsum or portland cement binders and lightweight, asbestos free, mineral, or synthetic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.

D. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:

1. Dry Density: 15 lbs./cu. ft. typically for average and individual densities regardless of density indicated in referenced fire-resistance design, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605/E 605M.

2. Thickness: Provide minimum average thickness required for each fire-resistance design indicated according to ASTM E 605/E 605M.
3. Bond Strength: 200 lbf/sq. ft. minimum per ASTM E 736/E 736M:

    a. If surfaces of structural steel receiving sprayed fire-resistive material are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance Directory." Provide bond strength indicated in referenced UL fire-resistance criteria.

4. Air Erosion: Maximum weight loss of 0.001 g/sq. ft. in 24 hours per ASTM E 859.
5. Fire-Test-Response Characteristics: Provide sprayed fire-resistive materials with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

    a. Flame-Spread Index: 10 or less.
    b. Smoke-Developed Index: 0.

2.2 AUXILIARY FIRE-RESISTIVE MATERIALS

A. General: Provide auxiliary fire-resistive materials that are compatible with sprayed fire-resistive materials and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Adhesive for Bonding Fire-Resistive Material: Product approved by manufacturer of sprayed fire-resistive material.

C. Water: Potable. Provide water with sufficient pressure and volume to meet the fireproofing application schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with installer and representative of the testing laboratory present, to determine that they are in satisfactory condition to receive sprayed fire-resistive material. Contractor, Installer, and testing laboratory shall submit written statement of each area’s substrate acceptability to the Architect prior to beginning application of fire-resistive materials. A substrate is in satisfactory condition if it complies with the following:

1. Substrates comply with requirements in the Section where the substrate and related materials and construction are specified.

2. Substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt, and other foreign substances capable of impairing bond of fire-resistive material with substrate under conditions of normal use or fire exposure.
3. Objects penetrating fire-resistive material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates prior to application.
4. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying fire-resistive material.

B. Prior to application of fireproofing to steel beams and decks verify that placement of concrete fill on floor and roof decks has been completed.

C. On roof decks without concrete fill complete all roofing applications and roof mounted equipment installation prior to application of fireproofing to the underside of supporting beams.

D. Do not proceed with installation of fire resistive materials until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, loose mill scale, and incompatible primers, paints, and other foreign substances which may impair proper adhesion of fireproofing to substrate.

B. Metal Lathing: Where required by rated assembly and bond, install metal lath, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer. Attach lathing accessories where indicated or required for secure attachment to substrate.

C. Cover other work subject to damage from fallout or overspray of fire-resistive materials before application. Provide temporary enclosure as required to confine spraying operations, protect the environment, and ensure maintenance of adequate ambient conditions for temperature and ventilation.

1. Cover floor slabs with polyethylene sheeting.

3.3 INSTALLATION, GENERAL

A. Comply with fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and spray on fire-resistive material, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

B. Extend fire-resistive material in full thickness over entire area of each substrate to be protected. Unless otherwise recommended in writing by sprayed fire-resistive material manufacturer, install body of fire-resistive covering in a single course.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to verify the adequacy of the Contractor's quality control of the sprayed-fire resistive materials work.

1. The independent testing and inspection agency will promptly submit weekly test results to the Contractor and Architect in the form required under ASTM E 605/E 605M and E 736/E 736M. The reports shall clearly indicate the location of each test, the test result at that location, and whether or not the tested fire resistive materials at each test location complies with the Contract Documents.

B. Testing and Inspection: Testing and inspection of completed applications of sprayed fire-resistive material shall be conducted as the work progresses. Each thickness, density and bond strength test location shall be selected at random by the testing and inspection agency. Do not proceed with application of sprayed fire-resistive material for the next area until test results for previously completed applications of sprayed fire-resistive material show compliance with requirements.

1. Visual Inspection:

a. Prior to Application: Visually inspect all surfaces intended to receive sprayed fire resistive materials prior to its installation for conformance with the requirements of the Contract Documents.
b. After Application: Visually inspect all surfaces that received sprayed fire resistive materials, including patched areas, for conformance with the requirements of the Contract Documents. Cracks in the fireproofing which expose the fireproofed substrate will not be permitted.
c. Final Inspection: After the work of adjacent trades has been completed, but before sprayed structural elements are enclosed, conduct a final visual inspection of sprayed-fire resistive materials work.

2. Thickness Testing:

a. Thickness for Floor and Roof Deck Assemblies: For each 1000 sq. ft. area, or partial area, on each floor, make four random tests for thickness per ASTM E 605/E 605M. Thickness measurements shall be selected from a square area 12 inches by 12 inches in size. For fluted decks a minimum of four measurements shall be made, located symmetrically within the square area including one each of the following: valley, crest, and sides. The average of the measurements shall be reported.

b. Thickness for Beams, Girders, Joists, Trusses and Columns: One test for beams, girders, joists, or trusses, and one test for columns, per 25 percent of structural members per floor per ASTM E 605/E 605M.

1) At beams and girders thickness measurements shall be made at nine locations around the beam or girder at each end of a 12 inch length.
2) At joists and trusses, thickness measurements shall be made at seven locations around the joist or truss at each end of a 12 inch length.
3) At wide flange columns, thickness measurements shall be made at twelve locations around the column at each end of a 12 inch length.
4) At hollow structural section and pipe columns, thickness measurements shall be made at a minimum of four locations around the column at each end of a 12 inch length.

3. Density Testing: For each 2,500 sq. ft. area, or partial area, on each floor, test one protected beam, one protected girder, one protected truss, one protected column, and one protected deck surface per ASTM E 605/E 605M.
4. Cohesion-Adhesion (Bond Strength) Testing: For each 2,500 sq. ft. area, or partial area, on each floor, test one protected beam, one protected column, and one protected deck surface, for cohesion and adhesion per ASTM E 736/E 736M.
5. Where testing and inspection reveals applications of sprayed fire-resistive material are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.

C. Apply additional sprayed fire-resistive material per manufacturer's written instructions where test results indicate that thickness does not comply with specified requirements.

D. Remove and replace, at Contractor's expense, including costs of delays to the work caused by removal and replacement, sprayed fire-resistive material where test results indicate that they do not comply with specified requirements for both cohesion and adhesion and for density.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 CLEANING, PROTECTING, AND REPAIR

A. Cleaning: Immediately after completing spraying operations in each confinable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces.

B. Cure exposed cementitious-sprayed fire-resistive material according to product manufacturer's written recommendations to prevent premature drying.

C. Protect sprayed fire-resistive material, according to advice of product manufacturer and Installer, from damage resulting from construction operations or other causes so fire protection will be without damage or deterioration at time of Substantial Completion.

1. Trades, other than fireproofing installer, who remove fireproofing material will be responsible for replacement of same.

D. Coordinate application of sprayed fire-resistive material with other construction to minimize need to cut or remove fire protection. As installation of other construction proceeds, inspect sprayed fire-resistive material and patch any damaged or removed areas prior to covering by other construction.

END OF SECTION 07 81 00

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Floors.
2. Roofs.
3. Walls and partitions.
4. Smoke barriers.

1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for each type of through penetration firestop system product indicated.

B. Through-Penetration Firestopping Schedule: Submit a Through-Penetration Firestopping Schedule indicating the type of through-penetration firestop system to be installed for each penetration. Indicate each kind of construction condition penetrated and kind of penetrating item. Include firestop design designation of testing and inspection agency acceptable to the authorities having jurisdiction that evidences compliance with requirements for each condition indicated.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

    a. Engineering judgment shall include both project name and contractor's name who will install firestop system as described in document

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified or licensed, by firestop system manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its firestop system materials to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.

1. The installer must have no less than 3 years of experience with fire stop installation.

B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multi-component materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Architect, Owner's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

        1) UL in its "Fire Resistance Directory."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Provide non-hardening resilient firestop material at penetrations, sleeves and passthroughs in acoustic construction assemblies.

1. Acceptable Products:

a. Specified Technologies, Inc.; Elastomeric Sealant ES100
b. Johns Manville; Firetemp CI Caulk.
c. 3M; Fire Barrier 2001 Silicone RTV Foam.
d. Hilti; Flexible Firestop Sealant CP 606.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.

K. Gypsum Products: The use of gypsum products for through-penetration firestopping is strictly prohibited.

2.4 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without damaging substrate or disturbing firestop system's seal with substrates.

3.3 INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION 07 84 13

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes sealants for the following applications:

1. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:

   a. Control and expansion joints in unit masonry.
   b. Joints between different materials listed above.
   c. Perimeter joints between materials listed above and frames of doors and windows and louvers.
   d. Other joints as indicated.

2. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:

   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints of exterior openings where indicated.
   c. Vertical control joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
   d. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
   e. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   f. Other joints as indicated.

3. Interior joints in the following horizontal traffic surfaces:

   a. Control and expansion joints in cast-in-place concrete slabs.
   b. Other joints as indicated.

1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for each joint-sealant product indicated and the following:

1. Written certification from manufacturers of joint sealants attesting that their products comply with specification requirements and are suitable for the use(s) indicated as verified through manufacturer’s in-house testing laboratory.

   a. Complete instructions for handling, storage, mixing, priming, installation, curing and protection of each type of sealant.

2. Laboratory and field test results confirming joint preparation (cleaning/priming), chemical compatibility, and proper adhesion for specified joint sealant for each of the joint profiles and substrate materials included in the design of this Project.

B. Samples: Submit samples of each type and color of exposed joint sealant required. Provide fully cured joint sealant samples in 3/4 inch wide joints 12 inches long formed between two strips of material to be sealed as they will appear on the Project.

1.3 INFORMATIONAL SUBMITTALS

A. Warranties: Submit specified warranties.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of joint sealant, and each type of structural silicone adhesive, from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Written warranty, signed by Installer agreeing to repair or replace elastomeric joint sealant work which has failed to provide a weathertight system within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Manufacturer's Warranties: Written warranties (weatherseal and stain resistance), signed by elastomeric sealant manufacturer agreeing to furnish elastomeric joint sealants to repair or replace those that fail to provide airtight and watertight joints, or fail in adhesion, cohesion, abrasion-resistance, stain-resistance, weather resistance, or general durability or appear to deteriorate in any other manner not clearly specified in the manufacturer's data as an inherent quality of the material within specified warranty period.

1. Warranty Period:

a. For Polyurethane Sealants: 5 years from date of Substantial Completion.
b. For Silicone Sealants: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as stated by sealant manufacturer's published data, and as substantiated by the manufacturer for each application through testing.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: Not more than 250 g/L.
2. Sealant Primers for Nonporous Substrates: Not more than 250 g/L.
3. Sealant Primers for Porous Substrates: Not more than 775 g/L.

C. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Colors: For fully concealed joints, provide manufacturer's standard color of sealant which has the best overall performance characteristics for the application shown. For exposed joints provide color as selected manufacturers standard colors

E. Manufacturer's Representative: Do not use elastomeric sealant produced by a manufacturer who will not agree to send a qualified technical representative to the Project site when requested, for the purpose of rendering advice concerning the proper installation of manufacturer's materials.

2.2 ELASTOMERIC JOINT SEALANTS

A. Two Part Polyurethane Sealants for Vertical Applications (Non-Sag):

1. Typical Exterior Wall Joints (Two-Part Polyurethane Sealants):

a. Properties:

1) Standards: Comply with ASTM C 920, Type M, Grade NS, Class 25, or Class 50; use NT, M, A and O.
2) Performance: Non-stain, non-bleed, non-streaking to sealed and adjacent substrates. The minimum peel adhesion value after 7 day immersion shall not be less than 13 pli when tested in strict accordance with ASTM C 794 Adhesion in Peel.

b. Products and Manufacturers: One of the following:

1) BASF Master Builders; MasterSeal NP 2.
2) Pecora Corporation; Dynatrol II.
3) Tremco an RPM Co, 240FC.

2.3 LATEX JOINT SEALANTS

A. Latex Sealant: Non-elastomeric, one-part, non-sag, paintable latex sealant that is recommended for exposed applications on the interior. Complying with ASTM C 834, Type OP (opaque sealants):

1. Products: Provide one of the following:

a. Pecora Corporation; AC-20 + Silicone.
b. DAP Products Inc.; Alex Plus Acrylic Latex Caulk Plus Silicone.
c. BASF; MasterSeal NP 520.
d. Tremco, an RPM Co.; Tremflex 834.

2.4 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: One of the following preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding backings of flexible plastic foam complying with ASTM C 1330, and of type indicated below. Select shape and density of cylindrical sealant backings in consultation with the manufacturer for proper performance in specific condition of use in each case.

1. Type C: Closed-cell polyethylene foam material with a surface skin, which is nonabsorbent to liquid water and gas, non-outgassing in unruptured state; one of the following:

a. HBR Closed Cell Backer Rod; Nomaco, Inc.
b. MasterSeal 920; BASF Master Builders.
c. Mile High Foam; Backer Rod Mfg., Inc.

C. Bond-Breaker Tape: Polyethylene, TFE fluorocarbon, or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Material recommended, as verified through compatibility and adhesion testing, by joint sealant manufacturer for the substrates indicated to be sealed.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants with joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and which will not stain nor mar the finish of surfaces adjacent to joints to which it is applied.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:

1. Remove foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), existing joint sealants, existing backer rods, existing waterproofing materials, existing water repellent treatments, oil, grease, water, surface dirt, and frost.
2. Clean concrete, masonry, unglazed surfaces of tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
3. Remove laitance and form-release agents from concrete.
4. Clean metal, glass, porcelain enamel, glazed surfaces of tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming (Elastomeric Sealants Only): Prime joint substrates with primers selected through the preconstruction compatibility and adhesion testing. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Joint Priming (Elastomeric Sealants Only): Prime joint substrates where recommended in writing by joint sealant manufacturer, based on prior testing and experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration beyond bond areas or onto adjoining surfaces.

D. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant and primer smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

1. Silicone Glazing Sealants: Refer to Section 08 80 00 "Glazing" for installation.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:

1. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

    a. Do not leave gaps between ends of sealant backings. Trim for tight fit around obstructions or elements penetrating the joint.
    b. Do not stretch, twist, puncture, or tear sealant backings.
    c. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry sealant backings.

2. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
3. Install weeps and vents into joints at the same time sealants are being installed. Unless otherwise shown on the drawings, or directed by the Architect, locate weeps and vents spaced as recommended by the sealant manufacturer and the window and curtain wall fabricator and erector. Do not install weeps and vents at outside building corners. Do not install vents at horizontal joints immediately below shelf angles, sills, and through wall flashings.

D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.

1. Apply sealants in the depth shown or, if none is shown, apply in accordance with the manufacturer's recommendations and the following general proportions and limitations:

    a. Apply elastomeric sealants in sidewalk, pavement, and similar horizontal joints to a depth equal to 75% of the joint width, but not less than 3/8 inch and not more than 3/4 inch.
    b. Apply elastomeric sealants, in joints not subject to traffic or other abrasion, to a depth equal to 50% of the joint width, but not less than 1/4 inch and not more than 1/2 inch.
    c. Apply non-elastomeric sealants to a depth approximately equal to the joint width.
    d. Fill horizontal traffic bearing joints slightly recessed to avoid direct contact with wheel, and pedestrian traffic. Fill horizontal traffic bearing joints with slope grade polyurethane sealants to a depth approximately equal to the joint width.

2. Pour self-leveling sealants to a depth approximately equal to the joint width.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform, beads to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces. Tool exposed surfaces of sealants to the profile shown, or if none is shown, tool slightly concave.

1. Use masking tape to protect adjacent surfaces of recessed tooled joints.
2. Provide a slight wash on horizontal joints where horizontal and vertical surfaces meet.
3. Against rough surfaces or in joints of uneven widths avoid the appearance of excess sealant or compound by locating the compound or sealant well back into joint wherever possible.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field-test exterior wall joint-sealant adhesion to joint substrates as follows:

1. Perform 10 tests for the first 1000 feet of joint length for each type of exposed exterior wall sealant and joint substrate.
2. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.

B. Field adhesion testing of sealants shall take place in the presence of a qualified technical representative of the sealant manufacturer.

1. Test Method: Test joint sealants by hand-pull method described below:

   a. Make knife cuts from one side of joint to the other, followed by two cuts approximately 3 inches long at sides of joint and meeting crosscut at one end. Place a mark 1 inch from cross-cut end of 3 inch piece.
   b. Use fingers to grasp 3 inch piece of sealant between cross-cut end and 1 inch mark; pull firmly at a 90-degree angle to the joint in the direction of side cuts and hold the sealant in this position for 10 seconds; following the 10 second time duration pull sealant at a 180 degree angle parallel to the joint and hold the sealant in this position for 10 seconds. Pull sealant away from joint to the distance recommended by sealant manufacturer for testing adhesion.
   c. For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.

2. The sealant manufacturer's qualified technical representative shall record test results, and observations of joint and sealant conditions, in a field adhesion test log.
3. Repair joint sealants pulled from test area as recommended by sealant manufacturer.

4. The sealant manufacturer shall provide written documentation of changes in product and/or application method required to address sealant failure, observe and document retesting as required by the Architect, and provide a written statement of compliance with applicable warranties.

C. Sealants not evidencing adhesive failure from testing will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.7 JOINT SEALANT SCHEDULE

A. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:

1. Perimeter joints between storefronts, balcony door, aluminum window, metal framing and adjacent materials: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
2. Control and expansion joints in cast-in-place concrete: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
3. Control and expansion joints in unit masonry: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
4. Joints between different materials listed above: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.
5. Perimeter joints between materials listed above and frames of doors and windows and louvers: Silicone Sealants for Vertical Applications (Non-Sag), Typical Exterior Wall Joints.

B. Exterior joints in the following horizontal traffic surfaces:

1. Control, expansion, and isolation joints in cast-in-place concrete slabs: Two-Part Polyurethane Sealant for Paving Applications.
2. Control and Expansion Joints in paving units, including steps and ramps: Two-Part Polyurethane Sealant for Paving Applications.
3. Control and expansion joints in joints between precast concrete tee flanges and shapes: Two-Part Polyurethane Sealant for Paving Applications.
4. Around perimeters of parking garage and balcony deck drains: Two-Part Polyurethane Sealant for Paving Applications.
5. Joints between different materials listed above: Two-Part Polyurethane Sealant for Paving Applications.

C. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:

1. Control and Expansion Joints on Exposed Interior Surfaces of Exterior Walls: Latex sealant.
2. Perimeter Joints of Exterior Openings Where Indicated: Latex sealant.
3. Vertical Control and Expansion Joints in Stone and Tile Surfaces: Latex sealant.
4. Horizontal Control and Expansion Joints in Stone and Tile Flooring Surfaces: Two-Part Polyurethane Sealant for Paving Applications.
5. Vertical Control Joints on Exposed Surfaces of Interior Unit Masonry and Concrete Walls and Partitions: Latex sealant.
6. Joints on Underside of Precast Beams and Planks: Latex sealant.
7. Perimeter Joints between Interior Wall Surfaces and Frames of Interior Doors, Windows, and Elevator Entrances: Latex sealant.
8. Perimeter Joints between Scalloped, Bent, or Warped Interior Wallboard Surfaces and Straight Trim: Latex Sealant.
9. Joints between Plumbing Fixtures and Adjoining Walls, Floors, and Counters: Mildew resistant silicone sealant.
10. Joints between Glass, and between Glass and Adjacent Substrates: Butt glazing sealant.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes

1. Hollow metal doors and frames.
2. The integration of a security system into the hollow metal door and framework is required. The Contractor shall be responsible for the total and complete coordination of the security system components into the Work.

1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for each product indicated. Include material descriptions, core descriptions, label compliance, sound, and fire-resistance ratings, and finishes for each type of door and frame specified.

B. Shop Drawings: Submit door and frame schedule using same reference designations indicated on Drawings. Include opening size(s), handing of doors, frame throat dimensions, details of each frame type, elevations of door design types, details of construction, location and installation requirements of door hardware and reinforcements, hardware group numbers, details of joints and connections, fire label requirements including fire rating time duration, maximum temperature rise requirements, and smoke label requirements.

1. Indicate routing of electrical conduit and dimensions and locations of cutouts in doors and frames to accept electric hardware devices.

1.3 INFORMATIONAL SUBMITTALS

1.4 QUALITY ASSURANCE

A. Hollow Metal Door and Frame Standard: Comply with the applicable provisions and recommendations of the following publications by Hollow Metal Manufacturers Association (HMMA) Div. of National Association of Architectural Metal Manufacturers (NAAMM), unless more stringent requirements are indicated in the Contract Documents:

1. HMMA "Hollow Metal Manual."
2. HMMA 861 "Guide Specifications for Commercial Hollow Metal Doors and Frames."

B. Manufacturer Qualifications: A firm experienced in manufacturing hollow metal doors and frames similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palleted, wrapped, or crated to provide protection during transit and Project site storage.

B. Inspect doors and frames, on delivery, for damage. Tool marks, rust, blemishes, and other damage on exposed surfaces will not be acceptable. Remove and replace damaged items as directed by Architect. Store doors and frames at building site in a dry location, off the ground, and in such a manner as to prevent deterioration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 or UL 10C "Standard for Positive Pressure Fire Tests of Door Assemblies." Fire classification labels at all doors with fire ratings greater than 20 minutes shall indicate the temperature rise developed on the unexposed surface of the door after the first 30 minutes of fire exposure.

1. Provide metal labels permanently fastened on each door which is within the size limitations established by the labeling authority having jurisdiction.

B. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257 or UL9.

C. Smoke-Control Door Assemblies: Provide assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

D. Thermally Rated Door Assemblies: Design, fabricate and install exterior door assemblies with the assembly U-factor maximum to comply with ASHRAE 90.1 and the IECC for the project specific geographic location of the building project when tested according to NFRC 100 (ASTM C 518).

2.2 MATERIALS

A. Hot-Rolled Steel Sheets: ASTM A 1011/A 1011M, CS (commercial steel), Type B, free of scale, pitting, or surface defects; pickled and oiled. Not less than 16 gauge, thick where frames are indicated to be built into exterior walls, hot dip galvanize after fabrication in compliance with ASTM A 153/A 153M, Class B.

B. Cold-Rolled Steel Sheets: ASTM A 1008/A 1008M, CS (commercial steel), Type B; free from scale, pitting, coil breaks, surface blemishes, buckles, waves, or other defects, exposed (matte) dull finish, suitable for exposed applications.

C. Inserts, Bolts, and Fasteners: Galvanized or cadmium plated steel.

1. Expansion Bolts and Shields: FS FF-S-325, Group III, Type 1 or 2.
2. Machine Screws: FS FF-S-92, carbon steel, Type III cross recessed, design I or II recess, style 2C flat head.

D. Hardware: Refer to Section 08 71 00 "Door Hardware."

2.3 DOORS

A. General: Provide flush-design doors, 1-3/4 inches thick, of seamless hollow construction, unless otherwise indicated. Construct doors with sheets joined at their vertical edges by continuous welding the full height of the door, or joined at vertical edges by 1 inch spot welds 6 inches on center, or intermittently welded seams. Voids between spot and intermediate welds shall be epoxy edge filled. Grind and finish all welds and edge fills flush to result in invisible seams on the door faces or vertical door edges.
1. For single-acting swing doors, bevel both vertical edges 1/8 inch in 2 inches.

B. Interior Door Core Construction: Doors shall be stiffened by continuous vertically formed steel sections which, upon assembly, shall span the full thickness of the interior space between door faces. These stiffeners shall be 20 gauge not more than 6 inches apart and spot welded to face sheets a maximum of 5 inches o.c. Place filler between stiffeners for full height of door.

C. Fire Door Cores: A continuous mineral fiberboard core permanently bonded to the inside face of the outer face sheet unless otherwise required to provide fire-protection and temperature-rise ratings indicated.

D. Hardware Reinforcement: Fabricate reinforcing from the same material as door to comply with the following. Offset reinforcement so that faces of mortised hardware items are flush with door surfaces.

1. Hinges and Pivots: 7 gauge thick by 1-1/2 inches wide by 9 inches.
2. Lock Front, Strike, and Flushbolt Reinforcements: 12 gauge thick by size as required by hardware manufacturer.
3. Lock Reinforcement Units: 14 gauge thick by size as required by hardware manufacturer.

4. Closer Reinforcements: 12 gauge thick one-piece channel by size as required by hardware manufacturer.
5. Other Hardware Reinforcements: As required for adequate strength and anchorage.
6. In lieu of reinforcement specified, hardware manufacturer's recommended reinforcing units may be used.
7. Exit Device Reinforcements: 12 gauge thick by 10 inches high by 4 inches wide centered on exit device case body, unless otherwise recommended by exit device manufacturer.

E. Electrical Requirements: Make provisions for installation of electrical items specified elsewhere; arrange so wiring can be readily removed and replaced.

1. Provide all cutouts and reinforcements required for hollow metal doors to accept security system components.
2. Doors with Electric Hinges and Pivots: Provide with metal conduit or raceway to permit wiring from electric hinge or pivot to other electric door hardware.

a. Hinge Location: Center for doors less than 90 inches tall or second hinge from door bottom for doors greater than 90 inches; top or bottom electric hinge locations shall not be permitted.

F. Interior Hollow Metal Doors:

1. Typical Interior Doors: Flush design with 16 gauge thick cold-rolled stretcher-leveled steel face sheets and other metal components from hot- or cold-rolled steel sheets.

2.4 WELDED FRAMES

A. Fabricate hollow metal frames, formed to profiles indicated, with full 5/8 inch stops, and of the following minimum thicknesses.

1. Frame heads at all masonry openings shall be formed to extend to the lowest CMU horizontal mortar joint.

B. Provide frames either saw mitered and full (continuously) profile welded, or machine mitered, and full profile welded, on back side at frame corners and stops with edges straight and true. Grind welds smooth and flush on exposed surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install doors and frames according to the referenced standards, the Architect reviewed shop drawings, and manufacturer's written recommendations and installation instructions.

B. Frames: Install frames where indicated. Extend frame anchorages below fills and finishes. Coordinate the installation of built-in anchors for wall and partition construction as required with other work.
   1. Welded Frames:

      a. Set masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.

         1) Set anchorage devices opposite each anchor location as specified and anchorage device manufacturer's written instructions. Leave drilled holes rough, not reamed, and free of dust and debris.

      b. Placing Frames: Remove temporary spreader bars prior to installation of the frames. Set frames accurately in position; plumb; align, and brace securely until permanent anchors are set.

         1) At concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
         2) Anchor bottom of frames to floors through floor anchors with threaded fasteners.
         3) Field splice only at approved locations indicated on the shop drawings. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
         4) Remove spreader bars only after frames are properly set and secured.

   2. At fire-rated openings, install frames according to NFPA 80.

C. Doors:

   1. Fire-Rated Doors: Install with clearances as specified in NFPA 80.
   2. Smoke Control Doors: Install according to NFPA 105.

D. Apply hardware in accordance with hardware manufacturer's instructions and Section 08 71 00 "Door Hardware." Drill and tap for machine screws as required. Do not use self-tapping sheet metal screws. Adjust door installation to provide uniform clearance at head and jambs, and to contact stops uniformly. Adjust hardware items just prior to final inspection. Leave work in complete and proper operating condition.

3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items just before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.

B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

1. Finish Painting: Refer to Section 09 91 23 "Interior Painting" "

C. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise defective.

D. Institute protective measures required throughout the remainder of the construction period to ensure that the hollow metal doors and frames will be without damage or deterioration, at time of Substantial Completion.

END OF SECTION 08 11 13

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes: Finish Hardware for door openings, except as otherwise specified herein.

1. Door hardware for steel (hollow metal) doors.
2. Keyed cylinders as indicated.

B. Related Sections:

1. Division 6: Rough Carpentry.
2. Division 8: Hollow Metal Doors and Frames.
3. Division 26 Electrical
4. Division 28: Electronic Security

C. References: Comply with applicable requirements of the following standards. Where these standards conflict with other specific requirements, the most restrictive shall govern.

1. Builders Hardware Manufacturing Association (BHMA)
2. NFPA 101 Life Safety Code
3. NFPA 80 Ó Fire Doors and Windows
4. ANSI-A156 Ó Various Performance Standards for Finish Hardware
5. UL10C Ó Positive Pressure Fire Test of Door Assemblies
6. ANSI-A117.1 Ó Accessible and Usable Buildings and Facilities
7. DHI /ANSI A115.IG Ó Installation Guide for Doors and Hardware
8. IBC Ó International Building Code as adopted by AHJ

D. Intent of Hardware Groups

1. Should items of hardware not definitely specified be required for completion of the Work, furnish such items of type and quality comparable to adjacent hardware and appropriate for service required.
2. Where items of hardware aren't definitely or correctly specified, are required for completion of the Work, a written statement of such omission, error, or other discrepancy to be submitted to Architect, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.

1.2 SUBSTITUTIONS:

A. Items specified in this section are products which are of acceptable design.

B. Do not substitute products without Architect's written prior approval per Division 1. Requests for approval shall be submitted by factory authorized distributor firms representing the products proposed for substitution. Items that are noted to allow no substitution are matching existing materials and the owner’s material inventory for servicing the facility.

1.3 SUBMITTALS:

A. Comply with Division 1.

B. Special Submittal Requirements: Combine submittals of this Section with Sections listed below to ensure the "design intent" of the system/assembly is understood and can be reviewed together.

C. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.
3. Wiring diagrams for each electric product specified. Coordinate voltage with electrical before submitting.
4. Submit 6 copies of catalog cuts with hardware schedule.
5. Provide 9001-Quality Management and 14001-Environmental Management for products listed in Materials Section 2.2

D. Shop Drawings - Hardware Schedule: Submit 6 complete reproducible copy of detailed hardware schedule in a vertical format.

1. List groups and suffixes in proper sequence.
2. Completely describe door and list architectural door number.
3. Manufacturer, product name, and catalog number.
4. Function, type, and style.
5. Size and finish of each item.
6. Mounting heights.
7. Explanation of abbreviations and symbols used within schedule.
8. Provide electrical operation technical sheets including product schematics, point to point diagrams, and electrical requirements of all electrified hardware. Completely coordinate with the general contractor, electrical engineer, electrician, security access subcontractor and the installer. Operational descriptions are for demonstration only Ó verify operational intent with the owner, architect, and electrical engineer.

E. Templates: Submit templates and "reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

1. Templates, wiring diagrams and "reviewed Hardware Schedule" of electrical terms to electrical for coordination and verification of voltages and locations.

F. Samples:

1. 1 sample of Lever and Rose/Escutcheon design, (pair).
2. 3 samples of metal finishes

G. Contract Closeout Submittals: Comply with Division 1 including specific requirements indicated.

1. Operating and maintenance manuals: Submit 3 sets containing the following.

    a. Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
    b. Catalog pages for each product.
    c. Name, address, and phone number of local representative for each manufacturer.
    d. Parts list for each product.

2. Copy of final hardware schedule, edited to reflect, "As installed".
3. Copy of final keying schedule
4. As installed Wiring Diagrams for each piece of hardware connected to power, both low voltage and 110 volts.
5. One set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

1.4 QUALITY ASSURANCE

A. Comply with Division 1.

1. Statement of qualification for distributor and installers.
2. Statement of compliance with regulatory requirements and single source responsibility.
3. Distributor's Qualifications: Firm with 3 years' experience in the distribution of commercial hardware.

    a. Distributor to employ full time Architectural Hardware Consultants (AHC) for the purpose of scheduling and coordinating hardware and establishing keying schedule.
    b. Hardware Schedule shall be prepared and signed by an AHC.

4. Installer's Qualifications: Firm with 3 years experienced in installation of similar hardware to that required for this Project, including specific requirements indicated.
5. Regulatory Label Requirements: Provide testing agency label or stamp on hardware for labeled openings.

    a. Provide UL listed hardware for labeled and 20-minute openings in conformance with requirements for class of opening scheduled.

b. Underwriters Laboratories requirements have precedence over this specification where conflict exists.

6. Single Source Responsibility: Except where specified in hardware schedule, furnish products of only one manufacturer for each type of hardware.
7. Provide hardware for all openings, whether specified or not, in compliance with NFPA Standard No. 80, proper operation and local building code requirements. Where required, provide only hardware which has been tested and listed by UL or FM for types and sizes of doors required and complies with requirements of door and door frame labels. Label hardware, as required, for compliance with pressure testing criteria as dictated in IBC.
8. Provide hardware which meets or exceeds handicap accessibility per local building code requirements. Conform to the Americans with Disabilities Act (ADA) of 1990 as amended by the D.O.J. September 15, 2010, as adopted by the Authority Having Jurisdiction (AHJ).

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Comply with Division 1.

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Package hardware to prevent damage during transit and storage.
3. Mark hardware to correspond with "reviewed hardware schedule".
4. Deliver hardware to door and frame manufacturer upon request.

B. Storage and Protection: Comply with manufacturer's recommendations.

1.6 PROJECT CONDITIONS:

A. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security, and similar requirements indicated, as necessary for the proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents.

B. Review Shop Drawings for doors and entrances to confirm that adequate provisions will be made for the proper installation of hardware.

1.7 WARRANTY:

A. Refer to Conditions of the Contract

B. Manufacturer’s Warranty:

1. Closers: Lifetime

2. Exit Devices: Five Years
3. Locksets & Cylinders: Three years
4. All other Hardware: Two years.

1.8 OWNER¢S INSTRUCTION:

A. Instruct Owners personnel in operation and maintenance of hardware units.

1.9 MAINTENANCE:

A. Extra Service Materials: Deliver to Owner extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Division 1 Closeout Submittals Section.

1. Special Tools: Provide special wrenches and tools applicable to each different or special hardware component.
2. Maintenance Tools: Provide maintenance tools and accessories supplied by hardware component manufacturer.
3. Delivery, Storage and Protection: Comply with Owners requirements for delivery, storage, and protection of extra service materials.

B. Approximately six months after the acceptance of hardware in each area, the hardware installer shall:

1. Return to the project and re-adjust every item of hardware to restore proper function of doors and hardware.
2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
3. Replace hardware items which have deteriorated or failed due to faulty design, materials, or installation of hardware units.
4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware and submit to the Architect.

C. Maintenance Service: Submit for Owners consideration maintenance service agreement for electronic products installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. The following manufacturers are approved subject to compliance with requirements of the Contract Documents. Approval of manufacturers other than those listed shall be in accordance with Division 1.

Item:	Manufacturer:	Approved:
Hinges	Stanley Bommer,	McKinney
Locksets	Best 45H	Dorma M9000, Schlage L9000
Cylinders	Best Patented	Schlage Everest 29
Exit Devices	Precision 2000	Dorma 9000
Closers Dorma 8916	Best HD7016	
Protection Plates	Trimco Burns,	Rockwood
Door Stops	Trimco Burns,	Rockwood
Threshold & Gasketing	National Guard Reese,	Zero

2.2 MATERIALS:

A. Hinges: Shall be Five Knuckle Concealed Ball Bearing Hinges

1. Template screw hole locations
2. Bearings are to be fully hardened.
3. Bearing shell is to be consistent shape with barrel.
4. Minimum of 2 permanently lubricated non-detachable bearings on standard weight hinge and 4 permanently lubricated bearing on heavy weight hinges.
5. Equip with easily seated, non-rising pins.
6. Non-Removable Pin screws shall be slotted stainless steel screws.
7. Hinges shall be full polished, front, back and barrel.
8. Hinge pin is to be fully plated.
9. Bearing assembly is to be installed after plating.
10. Sufficient size to allow 180-degree swing of door
11. Furnish five knuckles with flush ball bearings
12. Provide hinge type as listed in schedule.
13. Furnish 3 hinges per leaf to 7-foot 6-inch height. Add one for each additional 30 inches in height or fraction thereof.
14. Tested and approved by BHMA for all applicable ANSI Standards for type, size, function, and finish
15. UL10C listed for Fire rated doors.

B. Mortise Type Locks and Latches:

1. Tested and approved by BHMA for ANSI A156.13, Series 1000, Operational Grade 1, Extra-Heavy Duty, Security Grade 2 and be UL10C.
2. Furnish UL or recognized independent laboratory certified mechanical operational testing to 4 million cycles minimum.
3. Provide 9001-Quality Management and 14001-Environmental Management.
4. Fit ANSI A115.1 door preparation
5. Functions and design as indicated in the hardware groups
6. Solid, one-piece, 3/4-inch throw, anti-friction latchbolt made of self-lubricating stainless steel
7. Deadbolt functions shall have 1 inch throw bolt made of hardened stainless steel

8. Latchbolt and Deadbolt are to extend into the case a minimum of 3/8 inch when fully extended
9. Auxiliary deadlatch to be made of one-piece stainless steel, permanently lubricated
10. Provide sufficient curved strike lip to protect door trim
11. Lever handles must be of forged or cast brass, bronze or stainless-steel construction and conform to ANSI A117.1. Levers that contain a hollow cavity are not acceptable
12. Lock shall have self-aligning, thru-bolted trim
13. Levers to operate a roller bearing spindle hub mechanism
14. Mortise cylinders of lock shall have a concealed internal setscrew for securing the cylinder to the lockset. The internal setscrew will be accessible only by removing the core, with the control key, from the cylinder body.
15. Spindle to be designed to prevent forced entry from attacking of lever
16. Provide locksets with 7-pin removable and interchangeable core cylinders
17. Each lever to have independent spring mechanism controlling it
18. Core face must be the same finish as the lockset.

C. Cylinders:

1. Provide the necessary cylinder housings, collars, rings & springs as recommended by the manufacturer for proper installation.
2. Provide the proper cylinder cams or tail piece as required to operate all locksets and other keyed hardware items listed in the hardware sets.
3. Coordinate and provide as required for related sections.
4. Provide cylinder cores as required to convert any existing cores to a new Best Cormax patented key system as directed by the required keying meeting.

D. Door Closers shall:

1. Tested and approved by BHMA for ANSI 156.4, Grade 1
2. UL10C certified
3. Provide 9001-Quality Management and 14001-Environmental Management.
4. Closer shall have extra-duty arms and knuckles
5. Conform to ANSI 117.1
6. Maximum 2 7/16-inch case projection with non-ferrous cover
7. Separate adjusting valves for closing and latching speed, backcheck, and delayed action
8. Provide adapter plates, shim spacers and blade stop spacers as required by frame and door conditions
9. Full rack and pinion type closer with 1½Ó/36MM minimum bore
10. Mount closers on non-public side of door, unless otherwise noted in specification
11. Closers shall incorporate the manufacturers adjustable delayed action feature.
12. Closers shall be non-handed and multi-sized.

E. Door Stops: Provide a dome floor or wall stop for every opening as listed in the hardware sets.

1. Wall stop and floor stop shall be wrought bronze, brass, or stainless steel.
2. Provide fastener suitable for wall construction.
3. Coordinate reinforcement of walls where wall stop is specified.

4. Provide dome stops where wall stops are not practical. Provide spacers or carpet riser for floor conditions encountered

F. Silencers: Furnish silencers on all interior frames, 3 for single doors, 2 for pairs. Omit where any type of seals occurs.

2.3 FINISH:

A. Designations used in Schedule of Finish Hardware - 3.05, and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18 including coordination with traditional U.S. finishes shown by certain manufacturers for their products

B. Powder coat door closers to match other hardware, unless otherwise noted.

C. Aluminum items shall be finished to match predominant adjacent material. Seals to coordinate with frame color.

2.4 KEYS AND KEYING:

A. Provide keyed brass construction cores and keys during the construction period. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway (or key section) as the Owner's permanent keying system. Permanent cores and keys (prepared according to the accepted keying schedule) will be furnished to the Owner.

B. Cylinders, removable and interchangeable core system: Best standard 7-pin.

C. Permanent keys and cores: Stamped with the applicable key mark for identification. These visual key control marks or codes will not include the actual key cuts. Permanent keys will also be stamped "Do Not Duplicate."

D. Transmit Grand Masterkeys, Masterkeys and other Security keys to Owner by Registered Mail, return receipt requested.

E. Furnish keys in the following quantities:

1. 2 each Grand Masterkeys
2. 4 each Masterkeys
3. 2 each Change keys each keyed core
4. 10 each Construction Keys
5. 1 each Construction Control keys
6. 1 each Permanent Control Keys

F. The Owner, or the Owner's agent, will install permanent cores and return the construction cores to the Hardware Supplier. Construction cores and keys remain the property of the Hardware Supplier.

G. Keying Schedule: Arrange for a keying meeting, and programming meeting with Architect Owner and hardware supplier, and other involved parties to ensure locksets and locking hardware, are functionally correct and keying and programming complies with project requirements. Furnish 3 typed copies of keying and programming schedule to Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine doors, frames, related items, and conditions under which Work is to be performed and identify conditions detrimental to proper and or timely completion.

1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 HARDWARE LOCATIONS:

A. Mount hardware units at heights indicated in the following publications except as specifically indicated or required to comply with the governing regulations.

1. Recommended Locations for Builder¢s Hardware for Standard Steel Doors and Frames, by the Door and Hardware Institute (DHI).
2. Recommended locations for Architectural Hardware for flush wood doors (DHI).
3. WDMA Industry Standard I.S.-1A-04, Industry Standard for Architectural wood flush doors.

3.3 INSTALLATION:

A. Install each hardware item per manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed on the substrate. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

B. Conform to local governing agency security ordinance.

C. Install Conforming to ICC/ANSI A117.1 Accessible and Usable Building and Facilities.

1. Adjust door closer sweep periods so that from the open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the landing side of the door.

D. Installed hardware using the manufacturers fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use Orvis-Nuts or similar products.

3.4 FIELD QUALITY CONTROL AND FINAL ADJUSTMENT

A. Contractor/Installers, Field Services: After installation is complete, contractor shall inspect the completed door openings on site to verify installation of hardware is complete and properly adjusted, in accordance with both the Contract Documents and final shop drawings.

1. Check and adjust closers to ensure proper operation.
2. Check latchset, lockset, and exit devices are properly installed and adjusted to ensure proper operation.

    a. Verify levers are free from binding.
    b. Ensure latchbolts and dead bolts are engaged into strike and hardware is functioning.

3. Report findings, in writing, to architect indicating that all hardware is installed and functioning properly. Include recommendations outlining corrective actions for improperly functioning hardware if required.

B. Approximately six months after the acceptance of hardware in each area, the hardware installer shall:

1. Return to the project and re-adjust every item of hardware to restore proper function of doors and hardware.
2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
3. Replace hardware items which have deteriorated or failed due to faulty design, materials, or installation of hardware units.
4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware and submit to the Architect.

3.5 SCHEDULE OF FINISH HARDWARE:

List of Manufacturers

BE	Best Access Systems	Locks, Cylinders
DM	Dorma USA	Closers
NA	National Guard	Weatherstrip, Thresholds
PR	Precision	Exit Device
ST	Stanley Hinges,	Wire Harnesses
TR	Trimco Flat Goods,	Door Stops

Finish Codes

Code	Description
626	Satin Chromium Plated
630	Satin Stainless Steel
689	Painted Aluminum

Option List

Code	Description
FL	Fire Exit Hardware (Precision)
CS	Counter Sinking of Kick and Mop Plates (Trimco)
B4E	Beveled 4 Edges - Kick Plates (Trimco)
SSMS/EA	Stainless Machine Screws/Expansion Anchors (NGP)
SMS-TEKS	Self Tapping Sheet Metal Screws (NGP)

SET #1 - Data Room - Card Access

Door: 001

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	630	ST
1	Exit Device	FL 2108 X V4908D	630	PR
1	Rim Cylinder	12E-72 PATD	626	BE
*1	Electric Strike	BES-F0162LM	630	BE
1	Closer/Stop	8916 S-DS	689	DM
1	Kick Plate	K0050 10" x 2" LDW B4E CS	630	TR
1	Gasketing	700 NA SMS-TEKS	NA	
1	Door Sweep	200 NA SMS-TEKS	NA	
1	Thermal Break Threshold	8513 SSMS/EA	NA	
*1	Wire Harness	WH-6E	ST	
*1	Wire Harness	WH-192	ST	
*1	Power Supply	RPSMLR2	PR	

Card activation momentarily releases strike and allows access. Card reader by security access. Do not cut gasket - template hardware accordingly. Verify threshold application.

SET #2 - Vendor Data Room

Door: 002

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	630	ST
1	Lockset	45H-7D14H PATD	630	BE
1	Closer/Stop	8916 S-DS	689	DM
1	Kick Plate	K0050 10" x 2" LDW B4E CS	630	TR
1	Gasketing	700 NA SMS-TEKS	NA	
1	Door Sweep	200 NA SMS-TEKS	NA	
1	Thermal Break Threshold	8513 SSMS/EA	NA	

Do not cut gasket - template hardware accordingly. Verify threshold application.

* Requires electronic coordination.

End of Section 08 71 00

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation reports for embossed, high-strength steel studs and tracks firestop tracks post-installed anchors and power-actuated fasteners.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for steel unless otherwise indicated.

2. Protective Coating: ASTM A 653/A 653M, G40, hot dip galvanized unless otherwise indicated.

C. Studs and Tracks: ASTM C 645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. CEMCO; California Expanded Metal Products Co.
b. ClarkDietrich Building Systems.
c. MarinoWARE.
d. MBA Building Supplies.
e. MRI Steel Framing, LLC.
f. Phillips Manufacturing Co.
g. Steel Network, Inc. (The).
h. Telling Industries.

2. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
3. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: available products that may be incorporated into the Work include, but are not limited to, the following:

1) Blazeframe Industries; Bare Slotted Track (BST/BST 2).
2) CEMCO; California Expanded Metal Products Co.; CST Slotted Deflection Track, SLP-TRK Slotted Deflection Track.
3) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
4) MBA Building Supplies; FlatSteel Deflection Track, Slotted Deflecto Track.
5) Metal-Lite; The System.
6) Steel Network, Inc. (The); VertiClip SLD, VertiTrack VTD.
7) Telling Industries; Vertical Slip Track, Vertical Slip Track II.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

2.2 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

E. Direct Furring:

1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 09 22 16

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.

1.2 ACTION SUBMITTALS

A. Product Data: for products specified specified.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

C. Handle gypsum board to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.5 FIELD CONDITIONS

A. Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Installation of gypsum board joint treatments shall not start until the space to receive gypsum board joint treatments is heated to maintain a continuous and uniform temperature of not less than 55 deg F, from one week prior to beginning of joint treatment until joint treatment is completed and thoroughly dry. Ventilation, either natural or supplied by fans, circulators or air conditioning systems shall be provided to remove excess moisture during joint treatment. Temperature requirements may be waived only on recommendation of gypsum board manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. General: For fire rated assemblies, provide materials, including accessories and fasteners produced by one manufacturer, or, when products of more than one manufacturer are used in a rated system, they shall be acceptable to authorities having jurisdiction.

2.2 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. Continental Building Products/Lafarge North America Inc.
5. National Gypsum Company.
6. USG Corporation.

B. Gypsum Board: ASTM C 1396/C 1396M.

1. Type X:

a. Thickness: 5/8 inch .
b. Long Edges: Tapered.
c. Location: Vertical surfaces, where required for fire-resistance-rated assembly, and where indicated on Drawings.

2.3 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of the products and joint treatment materials for each application indicated.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, flanges of trim accessories, and fasteners, use setting-type taping compound.
3. Second Coat: For filling over tape, beads, and fasteners. Use setting-type, sandable topping compound.
4. Third Coat: For finishing over tape, beads, and fasteners. Use drying-type, all-purpose compound.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90. One of the following:

1. SHEETROCK Acoustical Sealant; U.S. Gypsum.
2. AC-20 FTR; Pecora.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed door frames and structural framing with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840, GA-216, and the gypsum board manufacturer's recommendations, where standards conflict, the more stringent shall apply. Install specialty gypsum board as specified below except where manufacturer's instructions conflict; follow manufacturer's instructions for specialty performance board to maintain warranty coverage.

B. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

C. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints or avoid them entirely.

    a. Stagger abutting end joints not less than one framing member in alternate courses of board.
    b. At high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

D. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

E. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

F. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions.

G. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

H. Attach gypsum panels to framing provided at openings and cutouts.

I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Fit gypsum panels around ducts, pipes, and conduits.

2. Where partitions intersect open exterior and interior wall kickers, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by the wall kickers and other structural members; allow 1/4 to 3/8 inch wide joints to install sealant.
3. Where chase walls are shown, provide bracing between parallel rows of studs. Unless otherwise shown, provide gypsum board braces no less than 1/2 inch thick by 12 inches wide and cut to width of chase. Locate at quarter points in wall height between each pair of parallel studs. Fasten with not less than 3 screws at each stud.

J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4 to 1/2 inch wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

K. Cut openings in gypsum board for electrical outlets, piping, and other penetrations. Maintain close tolerances so that edges will be covered by plates and escutcheons. Cut both face and back paper. Do not install electrical outlets back to back on opposing sides of partitions.

L. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

1. Space screws a maximum of 12 inches o.c. for vertical applications.
2. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.
3. Install fasteners not less than 3/8 inch from ends or edges of gypsum board sheets, spacing fasteners opposite each other on adjacent ends or edges.
4. Begin fastening from center of gypsum board and proceed toward edges and corners.
5. Apply pressure on surface of gypsum board adjacent to fasteners being driven to ensure that gypsum board will be secured tightly to supporting members.

    a. Drive fastener with shank perpendicular to face of board.
    b. Drive screws with a power screwdriver as recommended by gypsum board manufacturer. Set heads of screws slightly below surface of paper without cutting paper.

3.3 INSTALLING TRIM ACCESSORIES

A. General: Fasten trim accessories according to manufacturer's written instructions for type, length, and spacing of fasteners.

B. Install corner beads at external corners.

C. Install control joints in locations indicated and where directed by the Architect for visual effect, or if not indicated or directed by the Architect, provide control joints in accordance with ASTM C 840 which is as follows:

1. Where a partition, wall, or ceiling traverses a construction joint (expansion, seismic, or building control element) in the base building structure.
2. Where a wall or a partition runs in an uninterrupted straight plane exceeding 30 linear feet.

3.4 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Apply joint treatment at gypsum board joints, flanges of interior trim and aluminum trim accessories, interior angles, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration and levels of gypsum board finish indicated. Produce surfaces free of tool marks and ridges ready for decoration of type indicated. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:

1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.
3. Level 3: Typically, not used.
4. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.
5. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface where gypsum board is indicated to receive wall coverings, semi-gloss and high gloss paints, and Italian plaster.

3.5 CLEANING AND PROTECTION

A. Clean floors of all gypsum board debris and leave broom clean. Excess material, scaffolding, tools, and other equipment are to be removed upon completion of the Work.

B. Provide final protection and maintain conditions that ensure gypsum board assemblies remain without damage or deterioration at time of Substantial Completion.

END OF SECTION 09 29 00

SECTION 09 65 36 - STATIC-CONTROL RESILIENT FLOORING

1.1 SUMMARY

A. Section Includes:

1. Static-control, rubber floor tile.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to static-control resilient flooring including, but not limited to, the following:

a. Examination and preparation of substrates to receive static-control resilient flooring.
b. Installation techniques required for specified products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For chemical-bonding compounds, indicating VOC content.
4. Laboratory Test Reports: For chemical-bonding compounds, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For each type of static-control resilient flooring. Include floor-covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

D. Samples: For each type of static-control resilient flooring and in each color, pattern, and texture required, in manufacturer's standard size, but not less than 6 by 9 inches.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in installation techniques required by manufacturer for specified static-control resilient flooring.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required for specified products.

1.7 PROJECT CONDITIONS

A. Maintain ambient temperatures in spaces to receive static-control resilient flooring within range recommended by manufacturer for period recommended in writing before installation, during installation, and after installation.

B. Close spaces to traffic during static-control resilient flooring installation.

C. Close spaces to traffic for period recommended in writing by manufacturer after static-control resilient flooring installation.

D. Install static-control resilient flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 STATIC-CONTROL, RUBBER FLOOR TILE SCRF01

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Flexco.

2. Roppe Corporation, USA.

3. Staticworx., Eclispe EC

B. Static-Control Properties: As determined by testing identical products in accordance with test method indicated by an independent testing and inspecting agency.

1. Electrical Resistance:

a. Material: Point-to-point and point-to-ground resistances between 1 ohms and 1000 ohms when tested in accordance with ASTM F150 ESD STM7.1.
b. Material in Combination with a Person: Average resistance of 35 x 10E6 ohms when tested in accordance with ESD STM97.1.

2. Static Generation:

a. ESD STM97.2: Less than 20 V when tested at 12 percent relative humidity with static-control footwear.
b. AATCC TM134: Less than 20 V when tested at 20 percent relative humidity with static-control footwear.

3. Static Decay: 5000 to 0 V in less than 0.25 seconds when tested in accordance with FED-STD-101C, Method 4046.1.

C. Critical Radiant Flux: 0.45 W/sq. cm or greater when tested in accordance with ASTM E648 or NFPA 253.

D. Composition: ASTM F1344, Class I-B (homogenous rubber, through-mottled pattern).

E. Surface: Smooth.

F. Thickness: 0.08 inch.

G. Size: 24 by 24 inches.

H. Colors and Patterns: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates in accordance with manufacturer's written instructions to ensure successful installation of static-control resilient flooring and electrical continuity of floor-covering systems.

B. Concrete Substrates: Prepare in accordance with ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with floor-covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended in writing by manufacturer. Proceed with installation only after substrate alkalinity is not less than 6 or more than 8 pH unless otherwise recommended in writing by flooring manufacturer.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb. of water/1000 sq. ft. in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install static-control resilient flooring until it is same temperature as space where it is to be installed.

1. Move static-control resilient flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum substrates to be covered by static-control resilient flooring immediately before installation.

3.2 INSTALLATION, GENERAL

A. Install static-control resilient flooring in accordance with manufacturer's written instructions.

B. Extend grounding strips beyond perimeter of static-control resilient floor-covering surfaces to ground connections.

1. For adhesively installed flooring, embed grounding strips in static-control adhesive.

C. Scribe, cut, and fit static-control resilient flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

1. Extend static-control resilient flooring below built-in items and permanent, but movable, items that allow for a flexible layout where indicated on Drawings.

D. Extend static-control resilient flooring into toe spaces, door reveals, closets, and similar openings.

E. Extend static-control resilient flooring to center of door openings where flooring or color transitions occur.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on static-control resilient flooring as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

G. Adhesive Installation: Adhere static-control resilient flooring to substrates using a full spread of static-control adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

H. Integral-Flash-Cove Base: Cove static-control flooring 4 inches up vertical surfaces. Support static-control resilient flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

3.3 INSTALLATION OF FLOOR TILE

A. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.

1. Lay floor tiles square with room axis.

B. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to test electrical resistance of static-control resilient flooring in accordance with ASTM F150 ESD STM7.1 for compliance with requirements.

1. Arrange for testing after the following:

a. Static-control adhesives have fully cured.
b. Static-control resilient flooring has stabilized to ambient conditions.
c. Ground connections are completed.

B. Static-control resilient flooring will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of static-control resilient flooring.

B. Protect static-control resilient flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

C. Cover static-control resilient flooring and protect from rolling loads until Substantial Completion.

END OF SECTION 09 65 36

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and field application of paint systems on the following interior substrates:

1. Gypsum board.
2. Wood and hardboard.

1.2 DEFINITIONS

A. General: The following terms apply to this Section. Gloss level shall be determined according to ASTM D 523.

1. Gloss Level 1(Flat, or Matte): Not more than 5 units at 60 degrees and 10 units at 85 degrees.
2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees.
3. Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
4. Gloss Level 4 (Satin or Low Luster): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees.
5. Gloss Level 5 (Semigloss): 35 to 70 units at 60 degrees.
6. Gloss Level 6 (Gloss): 70 to 85 units at 60-degrees.
7. Gloss Level 7 (High Gloss): More than 85 units at 60 degrees.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat, with texture to simulate actual conditions.

1. Provide stepped Samples, defining each separate coat, including primers. Use representative colors when preparing Samples for review. Resubmit until required gloss, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
3. Submit paint samples on hardboard, 12 inches square, of each color and texture required.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. VOC content.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore Family of Products (Benjamin Moore, Coronado, Corotech, Insl-x, LenMar)
2. PPG Paints (PPG)
3. Sherwin-Williams Co. (SW)

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers.

2.2 PAINT, GENERAL (PT##)

A. Material Compatibility: Provide materials for use within each paint system that are compatible with one another and with the substrates indicated, under conditions of service and application, as demonstrated by manufacturer based on testing and field experience. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: VOC content of not more than 50 g/LNonflat Paints and Coatings: VOC content of not more than 100 g/L.
3. Dry Fog Coatings: VOC content not more than 150 g/L.
4. Primers, Sealers, and Undercoaters: VOC content not more than 100 g/L.
5. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content not more than 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: VOC content not more than 340 g/L.
7. Pre-Treatment Wash Primers: VOC content not more than 420 g/L. Floor Coatings: VOC content not more than 100 g/L.
8. Shellacs, Clear: VOC content not more than 730 g/L.
9. Shellacs, Pigmented: VOC content not more than 550 g/L.

C. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.

E. Low-Emitting Materials: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

G. Colors and Gloss: As indicated in Finish Schedule on Drawings. Reference to a particular manufacturer's number or color name is used only as a convenience for the Architect in order to establish the Project color and gloss requirements. These references are not intended to describe the required generic paint systems. For generic paint system requirements, refer to the "Interior Paint Schedule" at the end of Part 3, as applicable to the respective conditions of use.

1. The selection of paint colors and gloss are indicated by manufacturer and color type; designated as "PT##."
2. Furnish the same lots, batches, etc. within the same contiguous areas of the building (i.e., corridors on the same floors, common rooms which adjoin each other, etc.).

2.3 PREPARATORY COATS

A. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

B. Primer Sealer, Latex, Interior:

1. Benjamin Moore; Ultra Spec 500 Interior Latex Primer (N534).
2. PPG; Speedhide Zero Interior Latex Sealer Quick-Drying (6-4900).
3. SW; ProMar 200 Zero VOC Interior Latex Primer (B28W02600).

C. Where manufacturer does not recommend a separate primer formulation on substrate indicated, use paint specified for finish coat.

2.4 WATER-BASED PAINTS

A. Latex, Interior, Gloss Level 1 (Flat):

1. Benjamin Moore; Ultra Spec 500 Interior Flat (N536).
2. PPG; SPEEDHIDE zero Interior Zero-VOC Latex Flat (6-4110XI).
3. SW; ProMar 200 Zero VOC Interior Latex Flat (B30-2600 Series).

B. Latex, Interior, Gloss Level 3 (Eggshell).

1. Benjamin Moore; Ultra Spec 500 Interior Eggshell (N538).
2. PPG; SPEEDHIDE zero Interior Zero-VOC Latex Eggshell (6-4310XI).
3. SW; ProMar 200 Zero Interior VOC Latex Eg-Shel (B20-2600 Series).

C. Latex, Interior, High Performance Architectural, Gloss Level 3 (Eggshell):

1. Benjamin Moore; Corotech PreCatalyzed Waterborne Epoxy Eggshell V342.
2. PPG; Pitt-Glaze WB1 Interior Eggshell Pre-Catalyzed Water-Borne Acrylic Epoxy (16-310).
3. SW; Pro Industrial Pre-Catalyzed Waterbased Epoxy Eg-Shel (K45W1150 Series).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with manufacturer's requirements for paint application. Comply with procedures specified in PDCA P4.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

3.2 PREPARATION

A. Remove hardware and hardware accessories, cover plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible, provide surface-applied protection before surface preparation and painting.

B. Before applying paint or other surface treatments, clean substrates of substances that could impair bond of paints. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified. Provide barrier coats over incompatible primers or remove and reprime.

1. Gypsum Wallboard: Repair all surfaces in gypsum wallboard with wallboard joint finishing compound or spackling compound, filled out flush and sanded smooth. Clean all surfaces and taped joints of dust, dirt and other contaminants and be sure they are thoroughly dry before applying paint.
2. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
3. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

4. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

    a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
    b. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.

D. Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tint each undercoat a lighter shade to facilitate identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in Finish Schedule on Drawings.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
4. Extend coatings in exposed surfaces, as required, to maintain system integrity and provide desired protection.

    a. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place.

5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

B. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

    a. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
    b. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
    c. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

2. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

    a. .
    b. .

3.4 CLEANING

A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

C. After completing painting operations in each space or area, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection, if any.

3.5 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from paint application. Correct damage to work of other trades by cleaning, repairing, or replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 INTERIOR PAINTING SCHEDULE

A. Gypsum Board Substrates:

1. Latex System:

    a. Primer: Sealer, latex, interior.
    b. Intermediate Coat: Latex, interior, matching topcoat.
    c. Topcoat: Latex, interior (gloss as indicated in Finish Schedule).

B. Steel Substrates:

1. High-Performance Architectural Latex System:

    a. Primer: Acrylic.
    b. Intermediate Coat: Latex, interior, high performance architectural; matching topcoat.
    c. Topcoat: Latex, interior, high performance architectural (gloss as indicated in Finish Schedule).

2. Semigloss Dry Fall Coating:
    a. Primer: Interior semigloss dry fall coating.

b. Intermediate Coat: Interior semigloss dry fall coating.
c. Finish Coat: Interior semigloss dry fall coating.

C. Steel (Factory-Primed) Substrates:

1. High-Performance Architectural Latex System:

a. Primer: Acrylic (applied over factory primer).
b. Intermediate Coat: Latex, interior, high performance architectural; matching topcoat.
c. Topcoat: Latex, interior, high performance architectural (gloss as indicated in Finish Schedule).

END OF SECTION 09 91 23

SECTION 21 22 00 - CLEAN AGENT FIRE EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1. Section 23 05 02 – Basic Mechanical Requirements
2. Electrical work as covered under the General Mechanical Requirements and Divisions 26 – 28, as applies to work in this division.

1.2 SCOPE

A. Provide complete automatic clean agent fire suppression systems (referred to as NOVEC 1230) in areas indicated on the drawings. The systems shall include but not be limited to charged NOVEC 1230 storage containers, piping, nozzles, control panel, detectors, wiring, annunciators, alarms and any and all other equipment necessary for a complete operational system.

B. It is the intent of this Specification for the Contractor to provide complete operable total flooding NOVEC 1230 fire suppression systems for the areas that will meet the requirements of NFPA and the Authority Having Jurisdiction. Furnish all design, material, and labor to complete the contract within the intent of these Specifications and Contract Drawings even though each and every item necessary is not specifically mentioned or shown. .

C. The system shall be a 3M NOVEC 1230 Suppression System (No alternates will be accepted). A connected main and reserve quantity of NOVEC 1230 fluid shall be provided. A separate piping system shall be provided for the main cylinder and the reserve cylinder.

D. Provide the amount of agent required to obtain the minimum uniform concentration for 10 minutes. Take into consideration such factors as unclosable openings (if any), run-down time of fans, time required for dampers to close (and requirements for any additional dampers), and any other feature of the facility that could affect establishing uniform concentration, and holding it. Examine the architectural and mechanical features of the applicable spaces required to hold the agent for the required period. Coordinate with and provide guidance to the Contractor to provide all architectural and mechanical features required to provide a sufficiently ‘tight' space to allow pressurization and concentration holding characteristics adequate to pass the testing required. Provide automatic isolation dampers in HVAC ducts and HVAC equipment shutdown as required to isolate space adequately to pass testing.

E. Clean agent must have a minimum safety factor 60% between the design concentration percentage and the No Observed Adverse Effect Level (NOAEL) for acute toxicity, including cardiac sensitization of 10%.

1.3 PRODUCTS

A. The system shall be complete in all ways. It shall include all mechanical and electrical installation, detection and control equipment, agent storage containers, NOVEC 1230 agent, discharge nozzles, pipe and fittings, manual release, abort stations, audible and visual alarm devices, auxiliary devices and controls, caution/ advisory signs, functional checkout and testing, training and all other operations necessary for a functional, U.L. Listed and/or F.M. approved NOVEC 1230 Clean Agent Suppression System.

B. Provide Protection for the Following Areas:

1. Server Room

C. The contractor shall be responsible for sealing and securing the protected spaces against agent loss and/or leakage during the 10-minute "hold" period.

D. The system(s) shall be actuated by a combination of ionization and/or photoelectric detectors installed at a maximum spacing of 250 sq. ft. (23.2 sq. mtr) per detector, in both the room and above ceiling protected spaces. If the airflow is one air change per minute, photoelectric detectors only shall be installed at a spacing not to exceed 125-sq. ft. (11.6 sq. mtr) per detector. (Ref. NFPA No. 72)

E. The system detection wiring shall be of an approved method.

F. Automatic operation of each protected area shall be as follows:

1. The actuation of one(1) detector within the space shall;

a. Illuminate the “ALARM” lamp on the control panel face.
b. Energize the alarm bell and an optional visual indicator.
c. Transfer two(2) sets of 10 amp rated auxiliary contacts, which can perform auxiliary functions, such as;

1) Operate door holders/closures on access doors.
2) Transmit a signal to a fire alarm system.
3) Shut down HVAC equipment.

d. Light an individual lamp on an optional graphic annunciator.

2. The actuation of a second detector within the space shall;

a. Illuminate the “PRE-DISCHARGE” lamp on the control panel face.
b. Energize an alarm horn or horn/strobe device.

c. Shut down the HVAC system and/or close dampers.
d. Start the time-delay sequence.
e. Enable SYSTEM abort sequence.

3. After completion of the time-delay sequence, the SYSTEM shall discharge and the following shall occur;

a. Illuminate a "SYSTEM FIRED" lamp on the control panel face.
b. Shutdown all power to high voltage equipment.

1.4 QUALITY ASSURANCE

A. Referenced Standards:

1. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto.

a. National Fire Codes (NFPA) Standards.
b. No. 2001 -Clean Agent Fire Extinguishing Systems.
c. No. 70 - National Electrical Code.
d. No. 75 - Protection of Electrical Computer and Data Processing equipment
e. Factory Mutual Approval Guide.
f. Underwriters Laboratory
g. National Electrical Manufacturers Association (NEMA) Publication.
h. Enclosures for Industrial Control and Systems.
i. Local authorities having jurisdiction.

B. Qualification:

1. The system and components shall be provided by one manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to refer to similar installations rendering satisfactory service.
2. The system shall be designed and installed by an experienced firm regularly engaged in the installation of automatic NOVEC 1230 fire extinguishing systems in strict accordance with NFPA standards. The Contractor shall have a minimum of five (5) years of experience in design, installation and testing of NOVEC 1230 fire suppressions systems. Experience shall include projects of similar type, size, and complexity.
3. The installing Contractor shall have access to an approved NOVEC 1230 charging station and provide certification of his capability to recharge the largest NOVEC 1230 system within 24 hours after discharge. Certification shall include information as to the amount of Contractor's bulk storage available.
4. The installing Contractor shall be an authorized stocking distributor of the manufacturer for the equipment included in the system so that immediate replacement parts can be made from inventory and, if needed, on an emergency basis.

5. The Contractor shall provide proof of available telephone communications on a twenty-four hour, seven-day-a-week basis; service personnel shall be available for emergency service at all times. NOVEC 1230 installer shall submit:

    a. Certificate of competence from the System Manufacturer
    b. Certificate of ability to recharge system within 24 hours.
    c. The Architect may reject any proposed installer who cannot show evidence of such qualifications.

C. Submittal data shall be in accordance with Division 1 and the following shall be submitted for review to the Architect prior to the start of installation:

1. Materials and equipment information shall include catalog cuts and technical data for each component or device used in the system. This shall include, but not be limited to:

    a. Manufacturer's Data: Submit the following:

        1) Detectors
        2) Manual discharge switches
        3) Control panel
        4) Release devices
        5) Clean agent storage containers
        6) Mounting brackets
        7) Nozzles
        8) Sequence of operation
        9) Warranty Information
        10) Operation and Maintenance Procedures

2. Manufacturer's certificate of acceptance of the qualifications of the installing Contractor to install, test, maintain and recharge the manufacturer's equipment.
3. Certificate of Installation: Submit certificate upon completion of fire protection work, stating that the work has been completed and tested in accordance with the specified standards, that there are not defects in the system and it is operational.

D. Shop drawings shall be accurately drawn to the same scale and orientation as the building Contract Drawings. System design shall be completely coordinated with the architectural, structural, mechanical, and electrical features of the building. The drawings shall indicate locations, installation details and operation details of all equipment associated with the NOVEC 1230 system. Piping and conduit routings shall be shown. Sequences of operation, electrical schematics and connection diagrams shall be provided to completely describe the operation of the NOVEC 1230 system controls. The Contractor shall illustrate the agent distribution system, provide calculations to demonstrate the volumetric concentrations, and prove the concentrations will be maintained throughout for a ten minute period following agent discharge. The following information is to be provided for each protected area:

1. Room dimensions and volume
2. Design temperature

3. Specific volume at design and maximum temperature
4. Any air change rate not shut down (CFM)
5. NOVEC 1230 required
6. Discharge time
7. Number and size of nozzles
8. Agent discharged per discharge nozzle
9. Computerized hydraulic calculations of the agent distribution system taking into account each component of piping and the frictional losses associated with that component. Concentration of agent at design and maximum temperature.

E. Submit blueprints and hydraulic calculations and one (1) set of reproducibles of the complete shop drawings of the NOVEC 1230 systems to the Architect for review. Written approval of the Architect shall be obtained before purchasing or installing any equipment.

F. Approval of Submittals will not relieve the Contractor of the responsibility for correcting nay errors, which may exist, or for meeting requirements of the Specifications. No partial submittals will be accepted.

1.5 PROJECT RECORD DRAWINGS

A. Upon completion of the work, the Contractor shall revise all fire protection drawings to agree with the construction as actually accomplished and stamp “As-Built.” Those drawings where no change is involved shall be likewise stamped.

B. All equipment locations (manual stations, alarms, detectors, control panels) shall be shown, as well as exact conduit and piping routing details and agent storage positions. All facilities modifications including door and damper installations, and modifications to insure required soak times, shall be illustrated.

C. Revised hydraulic calculations shall be provided for the system “As-Built” if different from originally designed.

D. See also the requirements of Division 1.

1.6 WARRANTIES

A. All NOVEC 1230 system components furnished under this contract shall be warranted against defective design, materials and workmanship for the full warranty time which is standard with the manufacturer and/or supplier, but in no case less than one year from the date of system acceptance. If the Contractor warrants the system or any component part of the system for any longer period of time, this longer warranty period shall be stated in the bid.

PART 2 - PRODUCTS

2.1 GENERAL

A. The NOVEC 1230 Clean Agent System materials and equipment shall be standard products of the supplier's latest design and suitable to perform the functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates produced by one manufacturer. All devices and equipment shall be U.L Listed and/or FM approved.

2.2 NOVEC 1230 STORAGE AND DISTRIBUTION:

A. The system design can be modular, central storage, or a combination of both design criteria. Each system shall have its own supply of clean agent.

B. Systems shall be designed in accordance with the manufacturer's guidelines.

C. Each supply shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.

D. Containers shall be super-pressurized, with dry Nitrogen, to an operating pressure of 360 psi @ 70F. (2500 kpa at 20C). Containers shall be of high-strength alloy steel construction and conform to NFPA 2001.

E. Each container shall have a pressure gauge to provide visual supervision of the container pressure.

F. Each container shall have a pressure relief provision that automatically operates when the internal temperature exceeds 150°F. (66°C).

G. Engineered discharge nozzles shall be provided, within the manufacturers guidelines, to distribute the NOVEC 1230 agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution.

H. Nozzles shall be available in pipe sizes 3/8” through 2.0” (BPS 10mm through 50mm). Each size shall be available in 180 degree and 360 degree distribution patterns.

I. Distribution piping, and fittings, shall be installed in accordance with the manufacturer's requirements, NFPA 2001 and approved piping standards and guidelines. Qualified individuals using good, accepted practices and quality procedures shall install all distribution piping. All piping shall be adequately supported and anchored at all directional changes and nozzle locations. All piping and appurtenances shall be rated for installation within a plenum.

J. All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.

K. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male thread ONLY.

2.3 MAIN FIRE ALARM CONTROL PANEL (NOVEC 1230 CONTROL PANEL)

A. The NOVEC 1230 control panel shall be a micro-processor based system capable of communicating with the following types of peripherals and accessories: smoke sensors, thermal sensors, contact monitoring modules, addressable supervised output modules, addressable releasing modules and addressable relay modules.

2.4 MANUAL RELEASE (ELECTRIC)

A. The electric manual release switch shall be a dual action device, which provides a means of manually discharging the Suppression System when used in conjunction with the Control System.

B. The Manual Release switch or Manual Pull station shall be a dual action device requiring two distinct operations to initiate a system actuation.

C. Manual actuation shall bypass the time delay and abort functions shall cause the system to discharge and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.

D. A Manual Release switch shall be located at each exit from the protected hazard and shall have an advisory sign provided at each location.

2.5 ABORT STATION

A. The optional Abort Station shall be continuous contact type and shall be located next to each manual switch.

B. The Abort Station shall be supervised and shall indicate a trouble condition at the Control Panel, if depressed, and no alarm condition exists.

C. "Locking" or "Keyed" abort stations shall not be permitted.

2.6 AUDIBLE AND VISUAL ALARMS

A. Alarm audible and visual signal devices shall operate from the Control Panel.

B. The Horn/Strobe devices shall be Fike P/N’s 20, or equal in quality, performance and features. An agent label shall be attached to the strobe lens when required.

C. The visual alarm unit shall be a Fike P/N 20 Vertical Strobe device, or equal in quality, performance and features.

D. A Strobe device shall be placed outside, and above, each exit door from the protected space. Provide an advisory sign, Fike P/N 02-3645, at each light location

2.7 CAUTION AND ADVISORY SIGNS

A. Provide signs, as required, to comply with NFPA 2001 and the recommendations of the NOVEC 1230 equipment supplier:

1. Entrance sign: (1) required at each entrance to a protected space. (Fike P/N 02-3646)
2. Manual Discharge signs: (1) required at each manual discharge station. (Fike P/N 02-3644)
3. Flashing Light sign: (1) required at each flashing light over each exit from a protected space. (Fike P/N 02-3645)

2.8 SYSTEM AND CONTROL WIRING

A. All system wiring shall be furnished and installed by the contractor.

B. All wiring shall be installed in electrical metallic tubing (EMT), or conduit, and must be installed and kept separate from all other building wiring.

C. All system components shall be securely supported independent of the wiring. Runs of conduit and wiring shall be straight, neatly arranged, properly supported, installed parallel and perpendicular to walls and partitions.

D. The sizes of the conductors shall be those specified by the manufacturer. Color-coded wire shall be used. All wires shall be tagged at all junction points and shall be free from shorts, earth connections (unless so noted on the system drawings), and crosses between conductors. Final terminations between the Cheetah control panel and the system field wiring shall be made under the direct supervision of a factory-trained representative.

E. All wiring shall be installed by qualified individuals, in a neat and workmanlike manner, to conform to the National Electrical Code, Article 725 and Article 760, except as otherwise permitted for limited energy circuits, as described in NFPA 72 -1993 edition. Wiring installation shall meet all local, state, province and/or country codes.

F. The complete system electrical installation, and all auxiliary components, shall be connected to earth ground in accordance with the National Electrical Code.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Inspection:

1. After the installation is complete, inspect the system by factory trained personnel in accordance with the manufacturer's recommended procedures.

B. Testing:

1. Conform to NFPA-2001, except as recommended herein.
2. Piping Integrity Test: Pressurize the piping with compressed air to 300 psig for 8 hours. If the pressure drops below 294 psig, isolate the leaking fittings, seal, and retest.
3. Functional Test: Fill the cylinders to 360 psig with nitrogen. Discharge the system to verify that no obstructions are present in the piping or nozzles. Verify flow from each nozzle.
4. Operational Test: Test each component in the system for its individual and integrated performance; test for alarm and supervision.
5. Room Integrity Test:

    a. Pressurize the space below the ceiling and above the ceiling with separate blowers to equal pressures.
    b. Measure the Below Ceiling Leakage Area (BCLA).
    c. Calculate the retention time. Passing criteria will be maintenance of 7 percent concentration for 10 minutes at a height of seven feet above the raised floor.
    d. Retesting: Should the room integrity test not attain passing criteria on the first or any subsequent attempts, coordinate modifications to the architectural and mechanical features of the space with the Contractor to provide a sufficiently tight space which will pass the test, at no additional cost to the Owner. Retest until passing criteria is obtained.
    e. Testing Instrumentation: UL approved, dual blower infiltrometer, door fan and associated computer software or equal.
    f. Upon acceptance by Owner, recondition the complete system, refill and replace containers, and place the system in operation within 24 hours. Provide written certification that all containers have been refilled as required.

C. Manufacturer's Field Services:

1. Inspections:

    a. Provide 2 inspections of each system during the 1-year warranty period. The first inspection at the 6 month interval after system acceptance and the second at the 12 month interval. Inspections include determination of agent container weight and pressure and that the system is in proper working order.
    b. Inspections include a complete checkout of the control and alarm system. Submit documents certifying satisfactory system conditions to the Owner upon completion of each inspection.

2. Warranty:

    a. All system components furnished under this contract guaranteed against defective design, materials and workmanship for 5 years from the date of system acceptance.
    b. Provide refill of the system should there be any accidental discharge of the system during the 5-year warranty period if discharge is due to faulty material, workmanship or servicing.

3.2 DEMONSTRATION

A. Provide operation training to each shift of the Owner's personnel. Include emergency procedures; abort functions, system control panel operation, trouble procedures, and safety requirements, and a complete demonstration of the system. Coordinate dates and times through the Owner not less than 2 weeks prior to session.

END OF SECTION 21 22 00

SECTION 22 21 23 - NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and Install:

1. Natural gas piping.
2. Valves and specialties.

B. Install Only:

1. Meter.
2. Primary pressure reducing valve and associated relief vent piping.
3. Emergency shut-off valves.

C. Gas Meter: The gas meter and piping upstream of meter will be provided by the Gas Utility Company and paid for by this Contractor.

1.2 SUBMITTALS

A. Manufacturer’s Product Data: Submit for:

1. Gas cocks.
2. Gas meter.
3. Emergency shut-off valves and relays.
4. Pressure reducing valves.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING

A. Above Ground:

1. Two Inch and Smaller:

a. Pipe: Schedule 40 black steel.
b. Fittings: 150 lb. malleable iron, threaded.

2. Over Two Inch:

    a. Pipe: Schedule 40 black steel, plain end.
    b. Fittings: Standard weight, butt weld.

3. All piping within return air plenums or concealed (inaccessible) in building construction shall be as called for piping over 2".

B. Underground:

1. Pipe: Schedule 40 black steel, ASTM A53, Grade B, seamless, plain end.
2. Fittings: Standard weight, steel.

    a. Two Inches and Smaller: Socket weld.
    b. Over Two Inch: Butt weld.

3. Coating:

    a. Pipe: AAPCA TGF-3.
    b. Fittings: Protecto Wrap No. 200.

        1) Primer: No. 1170

2.2 GAS COCKS

A. Description: Corrosion-resistant plug, permanently lubricated, corrosion-resistant bearings, suitable seals for intended service, lever operator.

2.3 PRESSURE REGULATING VALVES

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 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Fisher Control Valves and Regulators; Division of Emerson Process Management.

d. Invensys.
e. Richards Industries; Jordan Valve Div.

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: 100 psig (690 kPa).

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Actaris.
b. American Meter Company.
c. Eclipse Combustion, Inc.
d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
e. Invensys.
f. Maxitrol Company.
g. Richards Industries; Jordan Valve Div.

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: 2 psig (13.8 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Remove cutting and threading burrs before assembling piping.

B. Do not install defective piping or fittings.

C. Do not use pipe with threads which are chipped, stripped or damaged.

D. Use Teflon tape on male pipe threads.

E. Plug each gas outlet, including valves with a threaded plug or cap, immediately after installation, and retain until continuing piping or equipment connection is completed.

F. Do not install any valves or unions inside concealed areas or above ceiling in building.

G. Vent gas PRVs outside the building in accordance with local code.

H. Paint all exposed gas pipe with a minimum of 2 coats on rust resistant pipe.

3.2 BURIED PIPE

A. Coated Pipe: Follow IAPMO Standard IS 13-84.

B. Buried piping shall be buried 24” minimum.

1. All buried joints shall be welded and left exposed until testing has been completed.

3.3 TEST

A. Prior to initial operation, test and purge fuel gas piping in accordance with local code requirements or the International Fuel Gas Code.

1. Test at 65 psig minimum.
2. Repair or replace piping as required to eliminate leaks, and re-test.

END OF SECTION 22 21 23

SECTION 23 05 01/26 05 01 - MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RESPONSIBILITY

A. The Divisions 21 through 23 and 26 through 28 contractor(s) shall comply with the provisions of this section. The Divisions 21 through 23 contractor(s) shall verify electrical service provided by the electrical contractor before ordering any mechanical equipment requiring electrical connections. Provide submittals of all mechanical equipment to Division 26 through 28 contractor(s).

B. The final responsibility for properly coordinating the electrical work of this section shall belong to the Divisions 21 through 23 system contractor performing the work, which requires the electrical power.

1. Each Divisions 21 through 23 contractor shall be responsible for providing power wiring for certain devices as described in the specifications and on the drawings. This work shall be provided by a licensed electrician in accordance with all of the applicable provisions of the Division 26 through 28 specifications, NEC and local codes.

1.2 WORK INCLUDED

A. Carefully coordinate the interface between Divisions 21 through 23 (Mechanical) and Divisions 26 through 28 (Electrical) before submitting any equipment for review or commencing installation

1.3 DEFINITIONS

A. Automatic: Pertaining to a function, operation, process or device that, under specified conditions, functions without intervention by human operator.

B. Disconnect Switch: A mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a power source.

C. Motor Control Center: A floor-mounted assembly of one or more enclosed vertical sections having a common horizontal power bus and primarily containing motor starting units.

D. Control Circuit/Power: The circuit which carries the electrical signals of a control apparatus or system directing the performance of the controller but does not carry the main power circuit.

E. Manual Operation: Operation by hand without the use of any other power.

F. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who furnishes motor.

G. TC: Temperature Controls = Division 23 09 00 Contractor who furnishes control.

H. EC: Electrical Contractor = Divisions 26 through 28 Contractor.

I. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Fire Alarm System.

J. EP: Electric to Pneumatic Converter.

K. PE: Pneumatic to Electric Converter.

1.4 RESPONSIBILITY SCHEDULE

A. Responsibility: Unless otherwise indicated, all motors and controls for Divisions 21 through 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	**Furnished Under**	**Set In Place Under**	**Power Wiring Under**	**Control Wiring Under**
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
AHU Interior Marine Lights	MC	MC	EC	MC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
In Motor Control Centers (Note 4)	EC	EC	EC	TC
Motor Speed Controllers: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	EC or TC	TC
Push Button Stations, Pilot Lights	MC	EC	EC	EC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC or TC	EC or TC	EC or TC	TC
Equipment in Temperature Control Panels	TC	TC	TC	TC
Standalone Control Panels (BAS) (Note 6)	TC	TC	TC	TC

ITEM -	**Furnished Under**	**Set In Place Under**	**Power Wiring Under**	**Control Wiring Under**
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	TC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 3)	FA	FA	EC	FA
Fire Sprinkler Alarm (Note 3)	MC	MC	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	--	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	MC	EC	TC
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	FA	--	FA
Smoke Management Controls (Note 8)	FA	FA	EC	FA
Equipment Interlocks	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 7)	MC	MC	EC	FA
Smoke Control Dampers (for smoke management system)	MC	MC	EC	FA/TC
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC

Notes:

1. If furnished as part of factory wired equipment furnished and set in place by MC, wiring and connections by EC.
2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor.
3. Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28.
4. Electrical contractor is responsible for wiring from starter to motor unless factory wired.
5. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
6. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.

B. Power Wiring by Divisions 21 through 23: The electrical power for certain equipment provided under Divisions 21 through 23 has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21 through 23 trade requiring such power.

Sufficient power for this purpose shall be furnished as "spare" dedicated circuit capacity in Division 26's panelboards. All wiring, conduit and electrical devices downstream of the panelboards are the responsibility of the Divisions 21 through 23 trade requiring the power.

1. Such equipment is hereby defined as:

    a. Fire protection components requiring electrical power. Required connections are included in the Division 21 work, and will be shown by that contractor's engineered system design drawings.
    b. Condensate pumps. Provide power from associated unit or from nearby panelboard.

1.5 GENERAL REQUIREMENTS

A. Connections:

1. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

B. Starters:

1. Provide magnetic starters for all three phase motors and equipment complete with:

    a. Control transformers.
    b. 120V holding coils.
    c. Integral hand-off-auto switch.
    d. Auxiliary contacts required for system operation plus one (1) spare.
    e. Refer to Section 23 05 13 Motors, Starters and Drives.

C. Remote Switches and Pushbutton Stations:

1. Provide remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

D. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

E. Identification:

1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign permanently mounted to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

F. Control Voltage:

1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

G. Short Circuit Current Ratings

1. MC shall be responsible for coordinating the Short Circuit Current Ratings (SCCR) of all such equipment with the electrical short circuit study. SCCR for equipment shall be greater than the available fault current, as indicated on electrical one-lines.
2. Utilizing fuses to limit the available fault current is not acceptable.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.

1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
2. Plumbing vent piping.
3. Supply, return and exhaust ductwork.
4. Electrical conduit greater than 4” diameter.
5. Hydronic branch and mains (greater than 2”, but less than 12”).
6. Domestic water piping.
7. Fire sprinkler mains and leaders.
8. Hydronic branch piping (2” and less).
9. Domestic hot and cold-water branches.
10. Electrical conduit branch feeders.
11. Fire sprinkler branch piping and sprinkler runouts.

B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2”).

C. Examine the contract documents of all trades (e.g. all Divisions 21 through 23 and 26 through 28 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).

D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.

E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.

F. Provide access doors for all equipment, valves, clean-outs, actuators and controls which require access for adjustment or servicing and which are located in otherwise inaccessible locations.

1. For equipment located in “accessible locations” such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. “Normal maintenance” includes, but is not limited to: filter changing; greasing of bearings; using p/t ports for pressure or temperature measurements; and replacement of ballasts, fuses, etc.

PART 2 - PRODUCTS

2.1 MOTOR HORSEPOWER

A. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general condition 2.1. A., above.

B. Work under Divisions 21 through 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Divisions 26 through 28, before ordering the equipment.

1. If motor horsepowers are changed under the work of Divisions 21 through 23 without a change in duty of the motor’s driven device, coordination of additional electrical work (if any) and additional payment for that work (if any) shall be provided under the section of Divisions 21 through 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect/Engineer.

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 23 05 01/26 05 01

SECTION 23 05 02 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1 - General Requirements.

B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. Architect/Engineer shall decide which is more stringent.

C. Provisions of this section shall also apply to all sections of Divisions 21 through 23.

1.2 DEFINITIONS

A. The definitions of Division 1 and the General Conditions of this specification also apply to Divisions 21 through 23 contract.

B. “Contract Documents” constitute the drawings, specifications, general conditions, project manuals, etc., prepared by Engineer (or other design professional in association with Engineer) for contractor’s bid or contractor’s negotiations with the Owner. Divisions 21 through 23 drawings and specifications prepared by the Engineer are not construction documents.

C. “Construction Documents”, “construction drawings”, and similar terms for Divisions 21 through 23 work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer’s contract documents. These specifications detail the contractor’s responsibility for “Engineering by Contractor” and for preparation of construction documents.

D. “(N)” indicates "new" equipment to be provided under this contract.

E. “(E)” indicates "existing" equipment on site which may or may not need to be relocated as a part of this work.

F. “(R)” indicates existing equipment to be relocated as part of this work.

G. "Furnish" means to "supply" and usually refers to an item of equipment.

H. "Install" means to "set in place, connect and place in full operational order".

I. "Provide" means to "furnish and install".

J. “Equal” or "Equivalent" means "meets the specifications of the reference product or item in all significant aspects." Significant aspects shall be as determined by the Architect/Engineer.

K. "Work by other(s) divisions"; "re: _____ Division", and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractor's sole responsibility to coordinate the work of the contract between their suppliers, subcontractors, and employees. If clarification is required, consult Architect/Engineer before submitting bid. By inference, any reference to a "contractor" or "sub-contractor" means the entity, which has contracted with the Owner for the work of the Contract Documents.

L. By inference, any reference to a "contractor" or "sub-contractor" means the entity, which has contracted with the owner for the work of the Contract Documents.

M. "Engineer" means the design professional firm, which has prepared these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).

1.3 COORDINATION WITHIN DIVISIONS 21 THROUGH 23

A. Contract Documents:

1. General: The Contract Documents are diagrammatic showing certain physical relationships, which must be established within the Divisions 21 through 23 work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.
2. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Architect/Engineer during the progress of the work.
3. Discrepancies:

    a. Examine Drawings and Specifications of all Divisions of the work.
    b. Report any discrepancies to the Architect/Engineer and obtain written instructions before proceeding.
    c. Should there be a conflict within or between the Specifications or Drawings, the more stringent or higher quality requirements shall apply.
    d. Items called for in either specifications or drawings shall be required as if called for in both.

4. Constructability:

    a. Examine Drawings and Specifications of all Divisions of the work.
    b. Report any issues to the Architect/Engineer which may prevent installation of Divisions 21 through 23 work in accordance with the Contract Documents and the original construction contract.
    c. Report all issues within promptly after contract.

B. Be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service. This coordination shall include, but not be limited to the following:

1. Division 21 - Series contractor (Fire Protection Contractor) shall provide shop drawings to all other Division 21 through 23 contractors.
2. Division 23 09 00 and 23 05 93 - Contractors (Automatic Temperature Controls, Building Management and Test-Adjust-Balance Contractors) shall be provided with equipment product data and shop drawings as appropriate from other Division 21 through 23 and Divisions 26 through 28 contractors, and shall furnish the same information about control devices (such as valves, test wells, etc.) to the appropriate Divisions 21 through 23 Contractor.

C. Coordination Drawings:

1. Submit coordination drawings for all Divisions 21 through 23 work. The drawings shall be fully coordinated and signed off by all affected trades prior to submission. The coordination drawings shall include the following at a minimum.

    a. All major ductwork, piping, conduit and equipment.
    b. Reflected ceiling plans with light fixtures.
    c. Current architectural floor plans.
    d. Major structural elements.
    e. Elevations of piping ductwork or equipment.
    f. Sections through critical spaces.

2. The drawings shall be at a suitable scale (1/8”=1’-0” minimum) to clearly show information.
3. Any work installed without reviewed coordination drawings is done at the Contractor’s risk.

D. Electronic Drawings:

1. Electronic drawings are available from ME Engineers. One complete set of electronic drawings in Revit or CAD format to be provided to GC for distribution. Electronic drawings are for reference only and available only upon receipt of electronic document disclaimer.

E. Existing Conditions:

1. Inspect existing conditions prior to bidding.
2. Provide proper coordination of mechanical work with existing conditions.

F. Utility Connections:

1. Coordinate the connection of mechanical system with the Civil drawings and utility companies.

2. Comply with regulations of utility suppliers.
3. The Contract Documents indicate the available information on existing utilities and services, and on new services (if any) to be provided to the project by utility companies and agencies.

    a. Notify Architect/Engineer immediately if discrepancies are found.

4. Coordinate mechanical utility interruptions one week in advance with the Owner and the Utility Company.

    a. Plan work so that duration of the interruption is kept to a minimum.

1.4 COORDINATION WITH OTHER DIVISIONS

A. General:

1. Coordinate Divisions 21 through 23 work to the progress of the work of other trades.
2. Complete the entire installation as soon as the condition of the building will permit.

B. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order:

1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
2. Plumbing vent piping.
3. Supply, return and exhaust ductwork.
4. Electrical conduit greater than 4” diameter.
5. Hydronic branch and mains (greater than 2”, but less than 12”).
6. Domestic water piping.
7. Fire sprinkler mains and leaders.
8. Hydronic branch piping (2” and less).
9. Domestic hot and cold-water branches.
10. Electrical conduit branch feeders.
11. Fire sprinkler branch piping and sprinkler runouts.

C. Coordination with Electrical Work. Refer to Section 23 05 01.

D. Cutting and Patching: Refer to Division 1 and Section 23 05 03.

E. Chases, Inserts and Openings:

1. Provide measurements, drawings, and layouts so that openings, inserts and chases in new construction can be built in as construction progresses.

2. Check sizes and locations of openings provided.

    a. Any cutting and patching made necessary by failure to provide measurements, drawings, and layouts at the proper time shall be done at no additional cost to the Owner.
    b. Coordinate roof openings for all roof-mounted equipment. Openings on documents are diagrammatic and do not represent manufacturer specific requirements. Actual opening size, orientation and location, as well as structural coordination, is the responsibility of the mechanical contractor.
    c. Provide transitions on ductwork to accommodate actual roof openings.

F. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other Sections of the Specifications can be built at the proper time.

1.5 COORDINATION WITH EXISTING OCCUPIED AREAS

A. Minimize disruptions to operation of mechanical systems in occupied areas.

B. Coordinate any required disruptions with the Owner, one week in advance.

C. Provide temporary connections to prevent long disruptions.

1.6 ENGINEERING BY CONTRACTOR

A. The construction of this building requires the contractor to design several systems or subsystems. All such designs shall be the complete responsibility of the contractor.

B. Systems or subsystems which require engineering responsibility by the contractor include, but are not limited to:

1. Any system not fully detailed on the drawings.
2. Fire sprinkler.
3. Equipment supports, and hangers not fully detailed in the drawings.
4. Pipe hangers, sleeves and anchors not specified in these documents, or cataloged by the manufacturer.
5. Fire stopping
6. Duct supports, hangers and miscellaneous steel as required.
7. Temperature controls.
8. Refrigeration systems.
9. Piping expansion and contraction provisions.
10. Equipment supports, hangers.
11. Sizing and routing of condensate piping.

1.7 REGULATORY REQUIREMENTS

A. Codes: Comply with the following:

1. International Building Code 2018
2. International Mechanical Code 2018
3. International Plumbing Code 2018
4. National Electric Code (NEC) Latest Edition
5. International Fire Code 2018
6. Local Modifications to above Codes.

B. Applicable pamphlets of NFPA.

C. Requirements of Local Utility Companies:

1. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required for the project.

D. Other Regulations: Comply with the latest editions of the following:

1. U.S. and State Department of Labor Safety Regulations pertaining to the completed project.
2. Requirements of Fire Departments serving the project.
3. Regulations of the Health Department having jurisdiction.
4. Regulations of the Office of State Fire Marshal.
5. ASHRAE Energy Conservation Standard 90A.
6. ASHRAE Ventilation Standard 62.
7. Requirements of the State Oil Inspector.
8. Americans with Disabilities Act (ADA).
9. Clean Air Act.
10. Colorado Air Quality Control Commission Regulation #15.
11. Clean Water Act.

E. Additional Regulations: Follow additional regulations, which appear in individual Sections of these Specifications.

F. Contradictions: Where codes are contradictory, follow the most stringent, unless otherwise indicated in Plans or Specifications. Architect/Engineer shall determine which is most stringent.

G. Contract Documents Not in Compliance:

1. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer, in writing during the Bidding Period, of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be

held to complete all work necessary to meet these requirements without additional expense to the Owner.

2. Follow Drawings and Specifications where they are superior to Code requirements.

H. Permits:

1. Obtain all permits required by authorities and agencies having jurisdiction for the work of this Division.
2. Post permits as required.

I. Tap and Connection Fees:

1. Pay fees charged by Utilities for making connections, bringing service to property line, or to meter and similar services.
2. Investment fees or plant development fees, which are charges levied by Utilities to cover the cost of the utility system to be borne by this project, are not part of the work of this Division.

J. Inspections and Tests:

1. Arrange for all required inspections and tests.
2. Pay all charges.
3. Notify Architect/Engineer 48 hours before tests.
4. Submit one copy for Owners records of permits, licenses, inspection reports and test reports.

1.8 RECORD DRAWINGS

A. General Recording Procedure:

1. Maintain a blue-line set of Divisions 21 through 23 Contract Drawings in clean, undamaged condition, for mark-up of installations, which vary, substantially from the Contract Drawings.
2. Record changes drawn to scale and fully dimensioned, as specified in Division 1.

    a. Work concealed behind or within other work, in an inaccessible arrangement.
    b. Mains and branches of piping systems:

        1) with valves and control devices located and numbered.
        2) with concealed unions located.
        3) with items requiring maintenance located (traps, strainers, expansion compensators, tanks, etc.).

    c. Underground piping and ducts, both exterior and interior.

d. Ductwork layouts, including locations of coils, dampers, filters, boxes and similar units.
e. Concealed control system devices and sensors.

B. Corrected Drawings:

1. Obtain a set of contract drawings on CAD.
2. Update the CAD files to reflect as-built conditions.
3. Transmit corrected CAD files and plots as a submittal to the Architect/Engineer for Owner's use and record.

C. Temperature Control Drawings:

1. Indicate as-built conditions of work under this contract including:

a. Ladder wiring diagram.
b. Pneumatic schematic diagrams.
c. One line system diagram.
d. Control schematic of equipment with control devices located and identified.
e. Wiring or tubing termination diagrams.
f. List of materials.
g. Floor plan indicating all device locations.
h. Control sequences.
i. Indicate electrical power source for each point of connection to the electrical system.

2. Reproducible temperature control drawings shall be delivered to the Architect/Engineer prior to Owner's acceptance of project.

1.9 OPERATING AND MAINTENANCE DATA

A. Submission:

1. Submit electronic and hard copy of Operating and Maintenance Manuals prior to scheduling systems demonstration for the Owner, as specified in Division 1.
2. Bind each Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings.

a. Mark the back spine of each binder with system identification and volume number.

B. Required Contents:

1. Manuals shall have index with tab dividers for each major equipment section to facilitate locating information on specific piece of equipment.

2. Identify data within each section with drawing code numbers as they appear on Drawings and Specifications. Include as a minimum the following data:

    a. Alphabetical list of system components, with the name, address and 24 hour telephone number of the company responsible for servicing each item during the first year of operation. Include point of contact for company.
    b. Operating instructions for complete system including:

        1) Emergency procedures for fire and failure of major equipment.
        2) Major start, operation and shut-down procedures.

    c. Maintenance Instructions for each piece of equipment including:

        1) Equipment lists.
        2) Proper lubricants and lubricating instructions for each piece of equipment.
        3) Necessary cleaning, replacement and/or adjustment schedule.
        4) Product Data.
        5) Installation instructions.
        6) Parts lists.
        7) Complete wiring diagrams.

    d. Temperature control diagrams and O&M information as specified above (as-built).
    e. Marked or changed prints locating concealed parts and variations from the original system design (as-built drawings).
    f. Balancing Report.
    g. Valve schedule and associated piping schematics. See Division 23 05 53, Mechanical Identification.
    h. Copies of any extended equipment warranties, which are greater than one year.

1.10 WARRANTIES

A. The warranty period is one year after Date of Acceptance.

1. During this period, provide labor and materials as required to repair or replace defects in the mechanical system at no additional cost to the Owner. Provide certificate with O&M manual submittal which guarantees same-day service response to Owners call for all such warranty service.
2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies in O&M manuals. Such equipment shall include:

    a. CRAC Units, five (5) years.

3. Provide extended manufacturers warranties to cover one full year from date of acceptance if standard warranty starts any time prior to that date.

4. Provide factory trained service personnel for all warranty work on the following equipment:

    a. CRAC Units

B. Refer to Division 1 for additional requirements.

1.11 SCOPE

A. The Contractor shall:

1. Supply all labor, transportation, materials, apparatus, light, and tools necessary for the completion of the mechanical work.
2. Install, maintain, and remove all construction equipment.
3. Be responsible for safe, lawful, and proper construction maintenance.
4. Construct, in the best and most workmanlike manner, a complete project and everything properly incidental thereto, as shown on the Drawings, as stated in the Specifications, or reasonably implied therefrom, all in accordance with the Contract documents.

1.12 MANDATORY GOVERNING PROVISION

A. Omissions of words or phrases, such as “the Contractor shall,” “in conformity with,” “shall be,” “as noted on the Drawings,” “according to the Drawings,” “an,” “the,” and “all,” are intentional.

B. Omitted words or phrases shall be supplied by inference.

1.13 PROTECTION OF PROPERTY AND MATERIALS

A. Provide protection against dust migration, rain, wind, storms, frost, or heat, so as to maintain all work, materials, apparatus, and fixtures free from injury or damage.

B. At end of each day’s work, cover all new work likely to be damaged.

C. Do not interrupt the integrity of the building security overnight.

D. Refer to Division 1 for additional requirements.

1.14 OWNER FURNISHED EQUIPMENT

A. All equipment called out in the Specifications or shown on the Drawings as “Owner-Furnished Equipment” shall be installed and connected under this Contract. Provide rough-ins for all future connections indicated.

1.15 TEMPORARY FACILITIES

A. Light, Heat, Power, etc.

1. Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 1.
2. Contractor shall be responsible for maintaining the equipment in an as-new condition. Equipment will not be turned over to the Owner until it is brought up to as-new condition.
3. The contractor shall be responsible for maintaining acceptable indoor air quality in adjacent occupied spaces.

B. Use of Permanent Building Equipment for Temporary Heating or Cooling.

1. Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. The contractor shall protect all equipment and systems as directed by the engineer. The warranty period shall not start until the equipment is turned over to the Owner for their use. The contractor shall provide extended warranties for parts and labor for all such equipment. Equipment shall not be turned over to the Owner until the temperature controls have been tested and accepted by the Owner and Engineer.

1.16 INSTALLATION GENERAL REQUIREMENTS

A. Furnish, apply, install, connect, erect, clean, and condition manufactured materials and equipment as recommended in manufacturer's printed directions (maintained on job site during installation).

B. Provide all attachment devices and materials necessary to secure materials together or to other materials.

C. Make allowance for ample and normal expansion and contraction for all building components and piping systems that are subject to such.

D. Install materials only when conditions of temperature, moisture, humidity, and conditions of adjacent building components are conducive to achieving the best installation results.

E. Erect, install, and secure components in a structurally sound and appropriate manner.

F. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed.

G. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.

H. Handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, or other disfigurement.

I. Conduct work in a manner to avoid injury or damage to previously placed work.

J. Any work so impaired or damaged shall be replaced at no expense to Owner.

K. Fabricate and install materials true to line, plumb, and level.

L. Leave finished surfaces smooth and flat, free from wrinkles, warps, scratches, dents, and other imperfections.

M. Furnish materials in longest practical lengths and largest practical sizes to avoid all unnecessary jointing.

N. Make all joints secure, tightly fitted, and as inconspicuous as possible by the best accepted practice in joinery and fabrication.

O. Consult Engineer for mounting height or position of any unit not specifically indicated or located on Drawings or specified in Specifications.

P. Job mixed multi-component materials used in the work shall be mixed in such regulated and properly sized batches that material can be used before it begins to “set”.

Q. Mixing of a partially “set” batch with another batch of fresh materials will not be accepted and entire batch shall be discarded and removed from site.

R. Clean all mixing tools and appliances that can be contaminated prior to mixing of fresh materials.

S. In addition to the above refer to each Section of the Specifications for additional installation requirements for the proper completion of all work.

PART 2 - PRODUCTS

2.1 QUALITY CONTROL

A. Refer to Division 1 of the Specifications.

B. The manufacturer of equipment or materials listed on the drawings or specifically indicated in the specification is the basis of design. If the drawings and specifications are in conflict, the drawings shall take precedence. Other manufacturers listed are considered general equivalents only. See below for coordination of substitutions.

C. Products by manufacturers not listed in this Specification may be submitted to the Engineer only during normal submittal procedure, and only as "substitutions". All bids must use basis of design or listed general equivalents.

D. Any manufacturer not listed shall be considered a substitution.

E. Items submitted as a substitution to the basis of design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:

1. Contract price adjustment.
2. Contract time adjustment.
3. Item by item breakdown of differences between basis of design and substituted item.
4. Operation, maintenance, and energy cost difference.

F. Coordination of general equivalents and substitutions: Where Contract Documents permit selection from several general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with mechanical and other work.

1. Provide necessary additional items so that selected or substituted item operates equivalent to the basis of design and properly fits in the available space allocated for the basis of design.
2. Provide all features which are standard on the basis of design.
3. Contractor is responsible for assuring that piping, conduit, duct, flue, and other service locations for general equivalents or substitutions do not cause access, service, or operational difficulties any greater than would be encountered with the basis of design.

2.2 GENERAL SUBMITTAL REQUIREMENTS

A. Refer to Division 1.

B. Coordination and Sequencing:

1. Coordinate submittals 2 weeks (min.) prior to expected order date so that work will not be delayed by submittals.
2. No extension of time will be allowed because of failure to properly coordinate and sequence submittals.
3. Do not submit product data, or allow its use on the project until compliance with requirement of Contract Documents has been confirmed by Contractor.
4. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
5. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, temperature control, and test and balance subcontractors.

C. Preparation of Submittals:

1. Refer to Division 1 requirements.
2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
3. Indicate any portions of work which deviate from the Contract Documents.

    a. Explain the reasons for the deviations.
    b. Show how such deviations coordinate with interfacing portions of other work.

4. Show Contractor's executed review and approval marking.
5. Provide space for Architect's/Engineer's "Action" marking.
6. Submittals which are received from sources other than through Contractor's office will be returned "Without Action".
7. Submittals shall be presented in a neat and legible fashion and shall be returned "Without Action" if presented in any other fashion.
8. Submittals shall have index with tab dividers for each component to facilitate locating information on specific pieces of equipment and products.

D. Quantities: Unless otherwise indicated in Division 1, submit electronic copy.

1. Refer to Division 1 requirements.
2. Multiple System Items: Where a required submittal relates to an operation or item of equipment used in more than one system, increase the number of final copies as necessary to complete the Maintenance Manuals for each system.
3. Preliminary Submittal: Provide a preliminary, two-copy submittal for automatic temperature controls and when product data is required (or desired by Contractor) for selection of options by Architect/Engineer.
4. General Distribution:

    a. Provide additional distribution of submittals (not included in foregoing copy submittal requirements) to Subcontractors, Suppliers, Fabricators, Installers, Governing Authorities and others as necessary for proper performance of the work.
    b. Include such additional copies in transmittal to Architect/Engineer where required to receive "Action" marking before final distribution.

        1) Show such distributions on transmittal forms.

E. Response to Submittals: Where standard product data have been submitted, it is recognized:

1. That the Submitter has determined that the products fulfill the specified requirements.
2. That the submittal is for the Architect's or Engineer's information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

F. If more than two submissions (either for shop drawings, as-built drawings, or test and balance reports) are made by the contractor, the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the contractor.

2.3 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS

A. Manufacturer's Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out significant portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:

    a. Sizes
    b. Weights
    c. Speeds
    d. Capacities
    e. Piping and electrical connection sizes and locations.
    f. Statements of compliance with the required standards and regulations.
    g. Performance data.
    h. Manufacturer's specifications and installation instructions.

B. Shop Drawings:

1. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale.

    a. Show clearance dimensions at critical locations.
    b. Show dimensions of spaces required for operation and maintenance.
    c. Show interfaces with other work, including structural support.

C. Test Reports:

1. Submit test reports which have been signed and dated by the firm performing the test.
2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.

D. Required equipment and shop drawing submittals:

1. Provide a submittal schedule with bid.
2. Provide equipment submittals for each item of equipment specified or scheduled in the contract documents.

3. Submittal Schedule shall show each item of equipment, applicable Section of the specifications where it is described, applicable Drawing number and schedule name where it is scheduled, date of Contractor's proposed submittal to Architect, required date to receive submittal from Architect and schedule order date.
4. Provide a Mechanical Shop Drawing Schedule for submission to the Architect with the Submittal Schedule. Refer to paragraph 1.3 -Coordination Within Divisions 21 through 23 above.
5. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
6. The shop drawing and product data review stamp notation requirements are defined as follows:

    a. "NO EXCEPTION TAKEN:" The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades are the responsibility of the contractor.
    b. "MAKE CORRECTIONS NOTED:" The reviewer indicated items observed that were not in compliance with the contract documents. The contractor shall not resubmit, but shall make corrections and provide corrected documents with the "Record Drawings."
    c. "REJECTED, REVISE AND RESUBMIT:" The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal do not relieve the contractor from meeting project schedules.
    d. "REJECTED:" The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal do not relieve the contractor from meeting project schedules.

7. If shop drawings are submitted and returned as "NO EXCEPTION TAKEN" or "MAKE CORRECTIONS NOTED" and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
8. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase "RESUBMITTAL NO. _____."
   Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

2.4 COMPATIBILITY

A. General: Provide products which are compatible with other products of the mechanical work and with other work requiring interface with the mechanical work.

B. Altitude Ratings: Except where noted otherwise, all ratings and capacities stated in the Contract Documents are at the altitude of the project, not sea level. Project Altitude shall be considered to be 6,700 feet.

C. Fuel Characteristics:

1. Review fuel characteristics with the Fuel Supplier designated by the Owner.
2. Determine burner or combustion equipment provisions needed for optimum performance. Provide equipment accordingly.

D. Power Characteristics:

1. For power characteristics of equipment supplied under Division 21 through 23 Sections, refer to the Sections of Divisions 26 through 28 and the Electrical Drawings for the power characteristics of each power-driven item of mechanical equipment.
2. Coordinate available power with Electrical Contractor before ordering equipment. Mechanical Contractor shall be responsible for ordering equipment to meet the available power characteristics.
3. See also Division 23 05 01 of these specifications.
4. If there is a conflict between Divisions 21 through 23 documents and Divisions 26 through 28 documents, alert the engineer. Do not order equipment prior to determining the proper electrical service. No contract cost adjustment will be allowed for equipment ordered in conflict with the available power characteristics.

2.5 SAFETY PROVISIONS

A. Equipment Nameplates: Provide power-operated mechanical equipment with a permanent nameplate attached by the manufacturer, indicating:

1. The manufacturer
2. Product name
3. Model number
4. Serial number
5. Speed
6. Capacity
7. Power characteristics
8. Labels of testing, listing, or inspecting agencies
9. Other similar data

B. Where manufacturer affixed nameplate is not available, Mechanical Contractor shall fabricate and attach nameplate.

C. Guards:

1. Unless equivalent guards are provided integral with the equipment, enclose each belt drive (including sheaves) on both side in a galvanized, one-inch, mesh screen of No. 18-gauge steel wire or expanded metal, fastened to an approved, structural steel frame, securely fastened to the equipment or floor.

2. Provide tachometer holes at shaft centers. Unless equivalent guards are provided integral with the equipment, install a solid guard of No. 20-gauge galvanized steel over the coupling of each item of direct-driven equipment.
3. Sides are not required on these guards except to ensure rigidity.

2.6 SAFETY PROVISIONS

A. Any refrigeration system containing CFC-11, CFC-12, HCFC-123, HCFC-22, or any of the other refrigerants listed in the Clean Air Act as a Class I or Class II Ozone Depleting Compound shall comply with the Clean Air Act and the Colorado Air Quality Control Commission Regulation #15.

B. As a minimum all systems shall be equipped with refrigerant recovery service valves, relief valves capable of resetting after activation, and for system with more than 50 pounds of charge, and isolateable receiver and/or condenser capable of holding the complete charge.

PART 3 - EXECUTION

3.1 COORDINATION OF MECHANICAL INSTALLATION

A. Inspection and Preparation:

1. Examine the work interfacing with mechanical work, and the conditions under which the work will be performed, and notify the Architect/Engineer of conditions detrimental to the proper completion of the work at original contract price.
2. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Layout:

1. Layout the mechanical work in conformity with the Contract Drawings, Coordination Drawings and other Shop Drawings, product data and similar requirements so that the entire mechanical plant will perform as an integrated system, properly interfaced with other work, recognizing that portions of the work are shown only in diagrammatic form.
2. Where coordination requirements conflict with individual system requirements, comply with the Architect’s or Engineer’s decision on resolution of the conflict.
3. Take necessary field measurements to determine space and connection requirements.
4. Provide sizes and shapes of equipment so the final installation conforms to the intent of the Contract Documents.

C. Integrate mechanical work in ceiling spaces with suspension system, light fixtures and other work so that required performances of each will be achieved.

3.2 PRODUCT INSTALLATION

A. Manufacturer's Instructions:

1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.
2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special project conditions.
3. If a conflict exists, notify the Architect/Engineer in writing, and obtain their instruction before proceeding with the work in question.

B. Movement of Equipment:

1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:

1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
2. Where mechanical products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck; position by crane or other device so as to avoid overloading the roof deck.

D. Return Air Path: Coordinate mechanical work in return air plenum to avoid obstructing return air path.

1. Do not make changes in layout which will reduce return air path cross-sectional areas. Minimum cross-sectional area will provide an average of 500 fpm and a maximum of 750 fpm velocity through return air plenum at specified supply air quantity unless otherwise noted.
2. Provide openings in any full height walls to allow for free movement of return air. Openings are to be sized for 500-750 fpm velocity. Notify the Architect/Engineer for any openings required in fire rated walls that are not shown on the contract drawings.
3. Report any obstructions by work of other Divisions to Architect/Engineer.

E. Clearances:

1. Install piping and ductwork:

    a. Straight and true.
    b. Aligned with other work.
    c. Close to walls and overhead structure (allowing for insulation).
    d. Concealed, where possible, in occupied spaces.

e. Out-of-the-way with maximum passageway and headroom remaining in each space. In spaces without ceilings, mechanical systems are to be installed tight to the underside of structure. Sloping pipe runs must originate tight to structure to allow for maximum installed height throughout.

2. Except as otherwise indicated, arrange mechanical services and overhead equipment with a minimum of:

   a. 7’0” headroom in storage spaces.
   b. 8’6” headroom in other spaces; where approved by Architect.

3. Do not obstruct windows, doors or other openings.
4. Give the right-of-way to piping systems required to slope for drainage (over other service lines and ductwork).

F. Access:

1. Provide for removal, without damage to other parts, of:

   a. Coils
   b. Humidifier manifolds
   c. Tubes
   d. Shafts
   e. Fan wheels
   f. Drives
   g. Filters
   h. Strainers
   i. Bearings
   j. Control components
   k. Other parts requiring periodic replacement or maintenance

2. Connect equipment for ease of disconnecting with minimum of interference with other work.
3. Provide unions where required.
4. Locate operating and control equipment and devices for each access.
5. Provide access panels where units are concealed by non-accessible finishes and similar work. See Section 23 05 03.
6. Extend all grease fittings to an accessible location.

3.3 PROTECTION OF WORK

A. All pipe ends, valves, ducts, and equipment left unconnected shall be capped, plugged or otherwise properly protected to prevent damage or the intrusion of foreign matter.

B. Do not allow any fans in the HVAC system to operate before the area served by the fan has been cleaned and vacuumed of all debris and dust which might enter the system.

C. Any equipment, duct or piping systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Engineer's satisfaction.

D. Initial fill of traps:

1. Provide initial water seal fill for all waste P-traps, condensate traps, or similar traps.

3.4 PROTECTION OF POTABLE WATER SYSTEMS

A. All temporary water connections shall be made with an approved back flow preventer.

B. All hose bibs shall have as a minimum, a vacuum breaker, to prevent back flow.

C. Direct connections to hydronic systems shall only be made through a reduced pressure back flow preventer.

3.5 PROTECTION OF SYSTEMS SERVING OCCUPIED SPACES

A. Where work is being performed in occupied spaces, or occupancy is to be phased in with ongoing construction, contractor shall prevent contamination of all systems serving the occupants including but not limited to:

1. Supply or Return Air

a. Systems shall be capped or provided with adequate particulate and gas phase filtration to prevent dust, chemical, or biological contamination. Particulate filters shall be as a minimum equivalent to those specified for the completed system.

2. Domestic Water

a. Isolate sterilized portions from non-sterilized portions.

3.6 REFRIGERATION SYSTEMS

A. All techniques involved in the installation of refrigeration systems shall be certified and trained in accordance with the International Mechanical Code and the applicable sections of the Clean Air Act.

B. No refrigerant shall be intentionally vented to the atmosphere. All refrigerant shall be recovered before opening a closed system for charging, evacuation, service or installation.

3.7 ASBESTOS

A. The identification and/or abatement of asbestos hazards is not part of this contract.

1. If asbestos is encountered, contact Owner for instructions.

3.8 START-UP

A. The Divisions 21 through 23 Contractor shall develop detailed start-up procedures, equipment checkout procedures and data forms for recording compliance with contract document performance criteria, and will assist in developing schedules for checkout and Owner acceptance.

B. The Divisions 21 through 23 Contractor shall include as part of the work of this contract, manpower, equipment, tools, ladders, instruments, etc. necessary to confirm start-up of Divisions 21 through 23 systems.

C. The Division 23 05 93, Test, Adjust and Balancing Contractor shall include as part of the work of his/her contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to assist the Divisions 21 through 23 Contractor in accomplishing his/her work.

D. The Divisions 21 through 23 Contractor shall be responsible for maintaining documentation of Start-Up activities until final acceptance of the project.

E. The documentation shall be kept current by the Divisions 21 through 23 Contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Divisions 21 through 23 Contractor shall surrender 3 completed copies of the documentation to the Owner's representative.

F. Before Testing, Adjusting, Calibration and Balancing (Division 23 05 93), the Divisions 21 through 23 Contractor shall confirm, in writing to the Owner, the following:

1. All equipment, components, and systems have been set, started-up, and adjusted.
2. Systems have been established at the appropriate temperatures and pressures for proper operation and performance.
3. All electric power connections, disconnects, fuses, circuit breakers, etc. are properly sized and installed.
4. The operation of all valves, dampers and sensors is positive (per the control sequences) and demonstrated.

G. Provide dated matrices for each item of equipment showing the date each of the start-up activities was witnessed or performed by the Divisions 21 through 23 Contractor.

1. Start-up and operating performance test documentation shall include all Division 21 through 23 equipment with scheduled capacities.

H. At the completion of the start-up; and test and balance, Divisions 21 through 23 shall conduct a 72 hour dynamic mode demonstration of the systems in the presence of the Owner.

3.9 DEMONSTRATION

A. Refer to Division 1 sections of the specifications regarding requirements of Record Drawings and Operation and Maintenance Manual submittal and systems demonstration.

1. Demonstrate to the Architect/Engineer that each system operates in accordance with the contract documents.
2. Explain the operation of each system to the Owner's Representative. Explain use of O&M manual in operating and maintaining systems.

B. Date and time of demonstration will be determined by Owner.

3.10 PROJECT CLOSEOUT

A. Refer to the individual sections of the specifications for individual closeout requirements.

B. Provide a written schedule of when systems are to be started up, tested and demonstrated along with dates for completion of the temperature controls and balancing. This schedule shall be submitted no later than 30 days prior to starting up and testing equipment.

C. The contractor shall notify the Architect/Engineer no later than 2 weeks in advance of system testing or demonstration.

END OF SECTION 23 05 02

SECTION 23 05 03 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1, General Requirements.

B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. The design team shall decide which is more stringent.

C. Provisions of this Section shall also apply to all Sections of Divisions 21 through 23.

1.2 SUMMARY

A. Furnish and install complete electric heat tracing systems as specified herein and as indicated on the mechanical and plumbing drawings. Heat Trace systems shall be installed to maintain the product UL listing with strict conformance to manufacturer's installation requirements.

B. The Division 23 contractor shall be responsible for fully functional and complete heat trace systems. Refer to specification section 23 05 01 Mechanical and Electrical Coordination for heat trace system scope responsibility.

1.3 SUBMITTALS

A. Manufacturer's Data - Submit manufacturer's data for:

1. Access panels.
2. Fire stopping materials.

    a. Application Data - Submit application data for firestopping materials showing UL required installation details for every combination of pipe material, penetrated structure, opening size and required fire rating within the scope of this project. Application data drawings shall include UL system number.

3. Heat Trace.

    a. Submit shop drawings for review prior to installation. Shop drawings shall show the overall system, component product data, each control location, cable lengths, electrical connection requirements, and electrical feed points. Provide a summary sheet of the entire system with capacity data for each cable length.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. See Division 8 for access panel types and finishes.

1. If panels are not specified in Division 8, comply with the following:

a. Manufacturers:

1) Acudor
2) Karp Associates, Inc.
3) Milcor
4) Zurn.

B. Construction:

1. Doors: 14-gauge steel.
2. Frames: 16-gauge steel.
3. Fire Rating: Equivalent to construction in which installed.
4. Latches: Flush or concealed, ¼ turn.
5. Finish: Compatible with finish of construction in which installed.

2.2 FIRE STOPPING MATERIAL

A. Manufacturers:

1. Design Basis: 3M.
2. Other acceptable manufacturers:

a. GE
b. Metalines
c. Hilti

B. General Requirements:

1. Products to be used shall have been tested in accordance with ASTM E 814-88, and be listed in the UL Fire Resistance Directory.

C. Bare Piping:

1. Model: FD 150, or CP-25.

D. Insulated Piping:

1. Model: CP-25 or FS-195, Intumescent.
2. “No-sag” or “self-leveling” as required.

E. Plastic Piping:

1. Model: CP-25 or FS-195, Intumescent.
2. “No sag” or “self-leveling” as required.

F. Accessories:

1. Provide fasteners, restricting collars, backing materials, and protective coatings as required to comply with the UL system listing.

2.3 ACOUSTICAL/PRESSURE SEALING MATERIAL

A. Manufacturers:

1. Manufacturers:

a. D.A.P. Mono Acoustical Sealant
b. GE
c. Metacaulk
d. Hilti
e. Pecora
f. Tremco
g. U.S.G.

B. General Requirements:

1. Non-skinning, non-hardening synthetic butyl rubber.
2. Effective adhesive seal for air and vapor barrier.
3. Acceptable for use in air plenums.

C. Accessories:

1. Provide fasteners and backing rods as recommended by manufacturer.

2.4 HEAT TRACE FOR PIPING FREEZE PROTECTION IN WATER PIPING AND FIRE PROTECTION SYSTEMS

A. Manufacturers:

1. Design Basis: Raychem/Pentair.
    a. Model: XL-Trace
2. Other acceptable manufacturers:
    a. Chromalox
    b. Thermon
    c. Emerson/Nelson

B. General Requirements:

1. Intent of heat trace system is to prevent freezing of fluid inside piping.
2. For fire protection systems, this specification is applicable to fire protection supply lines and standpipes only.
3. Heat tracing system shall be designed to maintain the water temperature within the piping of at least 40ºF with an ambient temperature of -20ºF (60 ºF ΔT)**.** The piping shall be insulated as specified in section 23 07 00 Mechanical Insulation.
4. Heat trace circuits shall be limited to a single piped utility only. Where multiple piped utilities in the same location are required to be heat traced, provide separately controlled circuits for each piped utility (i.e. domestic cold water, domestic hot water/recirculation, chilled water, etc. are each on separately controlled heat trace circuits). Domestic hot water and domestic hot water recirculation are allowed to be on the same heat trace circuit. Fire Sprinkler piping heat trace systems shall be dedicated to fire sprinkler piping only.

C. Heat Trace System Requirements:

1. Heating cables shall be UL listed and FM approved electrical heating strips. The electric heat tracing shall be a self-regulating type of parallel circuit construction consisting of a continuous inner core of self-regulating conductive material between two parallel copper bus wires suitable for operation on 277-Volt, 60 hertz, single phase power. Heat trace to be self-regulating at all points of connection and shall be capable of being overlapped or installed on plastic piping without overheating. The heat tracing strips shall be capable of being cut to the desired length in the field. Operating energy shall be conserved by the self-regulating feature of the heater materials, which automatically controls heat output in proportion to the heat requirement. Maximum operating temperature and exposure temperature shall be 150°F. Minimum installation temperature shall be 0°F.
2. The heat trace system shall include all required components for a fully functional system including heating cable, power connection, splice connections, tee connections, end seals, controls, contactors, power distribution panels, glass cloth adhesive tape, aluminum tape, accessories, and tools required for installation. Components shall be specific to the

application (i.e. above ground or below ground), pipe material, and insulation type. Heat traced piping shall be labeled “Electric Traced” with permanent labeling. Provide one label per 10 feet of pipe.

3. Above ground piping:

    a. Provide polyolefin jacket on heat trace cables.
    b. Non-fire protection systems: Heat Trace system shall be UL listed and FM approved for above ground general water piping freeze protection applications. Provide all components, connections, and accessories to maintain UL listing.
    c. Fire protection supply lines: Heat Trace system shall be UL listed for above ground fire protection supply line freeze protection applications. Provide all components, connections, and accessories to maintain UL listing. Comply fully with NFPA 13.
    d. Fire protection standpipes: Heat Trace system shall be UL listed for above ground fire protection standpipe freeze protection applications. Provide all components, connections, and accessories to maintain UL listing. Comply fully with NFPA 13.

4. Below ground piping:

    a. Provide fluoropolymer jacket on heat trace cables.
    b. Non-fire protection systems: Heat Trace system shall be UL listed and FM approved for below ground general water piping freeze protection applications. Provide all components, connections, and accessories to maintain UL listing.
    c. Fire protection supply lines: Heat Trace system shall be UL listed and FM approved for below ground fire protection supply line freeze protection applications. Provide all components, connections, and accessories to maintain UL listing. Comply fully with NFPA 13.
    d. Heating cables shall be protected from the pipe to the power connection box in UL listed water-sealed conduit, minimum ¾” diameter, suitable for location where installed.
    e. Power connections and end seals shall be made above ground within UL listed junction boxes or manufacturer’s connection kits.
    f. Closed cell, waterproof thermal insulation with fire-retardant, waterproof covering approved for direct burial is required. Refer to Section 23 07 00 Mechanical Insulation for additional requirements.

D. Heat Trace Circuits:

1. Heat trace circuit quantity for 277V/1PH systems shall be based on maximum cable lengths below. All heat trace cabling shall be served by 20A GFEP circuit breakers. Where multiple cables are required, all cables may be on the same circuit as long as maximum total cable length is not exceeded. Tables below are based on the basis of design heat trace product installed on metallic or plastic piping with insulation as specified. For fluids over 200°F, provide insulation thickness per section 230700

Mechanical Insulation and select cabling as recommended by heat trace system manufacturer.

Heat Trace Circuits for Metallic Piping Systems with Fluids 200°F and less – 277V/1PH				
Pipe Size (Metallic Pipe)	**Insulation Thickness**	**Design Heat Loss in Watts per linear foot**	**Cable Quantity and Power Output at 40°F Maintain Temperature and 60°F ΔT (Watts per linear foot)**	**Maximum Total Cable Length per circuit at -20°F startup temperature, 277V/1PH, 20A GFEP Circuit Breaker**
½" and ¾"	1-1/2"	1.82 W/lf	(1) cable at 7.2 W/lf	245 ft.
1"	1-1/2"	2.06 W/lf	(1) cable at 7.2 W/lf	245 ft.
1-1/4"	2"	1.96 W/lf	(1) cable at 7.2 W/lf	245 ft.
1-1/2"	2"	2.18 W/lf	(1) cable at 7.2 W/lf	245 ft.
2"	2"	2.44 W/lf	(1) cable at 7.2 W/lf	245 ft.
2-1/2"	2"	2.8 W/lf	(1) cable at 7.2 W/lf	245 ft.
3"	2"	3.18 W/lf	(1) cable at 7.2 W/lf	245 ft.
4"	2"	3.8 W/lf	(1) cable at 7.2 W/lf	245 ft.
6"	2"	5.12 W/lf	(1) cable at 7.2 W/lf	245 ft.
8"	2"	6.34 W/lf	(1) cable at 7.2 W/lf	245 ft.
10"	2"	7.66 W/lf	(2) cables at 7.2 W/lf each	245 ft.
12"	2"	8.88 W/lf	(2) cables at 7.2 W/lf each	245 ft.
14"	2"	9.62 W/lf	(2) cables at 7.2 W/lf each	245 ft.
16"	2"	10.84 W/lf	(2) cables at 7.2 W/lf each	245 ft.
18"	2"	12.06 W/lf	(2) cables at 7.2 W/lf each	245 ft.
20"	2"	13.28 W/lf	(2) cables at 7.2 W/lf each	245 ft.

Heat Trace Circuits for Plastic Piping Systems with Fluids 200°F and less – 277V/1PH				
Pipe Size (Plastic Pipe)	**Insulation Thickness**	**Design Heat Loss in Watts per linear foot**	**Cable Quantity and Power Output at 40°F Maintain Temperature and 60°F ΔT (Watts per linear foot)**	**Maximum Total Cable Length per circuit at -20°F startup temperature, 277V/1PH, 20A GFEP Circuit Breaker**
½" and ¾"	1-1/2"	1.82 W/lf	(1) cable at 5.4 W/lf	245 ft.
1"	1-1/2"	2.06 W/lf	(1) cable at 5.4 W/lf	245 ft.
1-1/4"	2"	1.96 W/lf	(1) cable at 5.4 W/lf	245 ft.
1-1/2"	2"	2.18 W/lf	(1) cable at 5.4 W/lf	245 ft.
2"	2"	2.44 W/lf	(1) cable at 5.4 W/lf	245 ft.
2-1/2"	2"	2.8 W/lf	(1) cable at 5.4 W/lf	245 ft.
3"	2"	3.18 W/lf	(1) cable at 5.4 W/lf	245 ft.
4"	2"	3.8 W/lf	(1) cable at 5.4 W/lf	245 ft.
6"	2"	5.12 W/lf	(1) cable at 5.4 W/lf	245 ft.
8"	2"	6.34 W/lf	(2) cables at 5.4 W/lf each	245 ft.
10"	2"	7.66 W/lf	(2) cables at 5.4 W/lf each	245 ft.
12"	2"	8.88 W/lf	(2) cables at 5.4 W/lf each	245 ft.
14"	2"	9.62 W/lf	(2) cables at 5.4 W/lf each	245 ft.
16"	2"	10.84 W/lf	(2) cables at 8.1 W/lf each	194 ft.
18"	2"	12.06 W/lf	(2) cables at 8.1 W/lf each	194 ft.
20"	2-1/2"	10.94 W/lf	(2) cables at 8.1 W/lf each	194 ft.

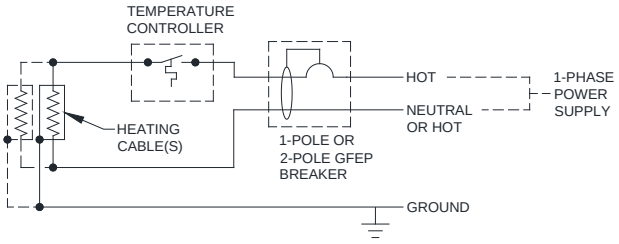
Adjust heat trace cabling power output and circuit quantity as required for design voltage, piping material, insulation type, insulation thickness, and selected manufacturer's maximum cable lengths.

E. Controls and Power Distribution:

1. Each heat trace circuit shall be served by a dedicated heat trace controller:

a. Provide microprocessor-based single-point heat trace electronic controller with programmable keypad and integral ground-fault protection. Basis of design: Raychem C910-485.

b. Controller shall include internal trip functionality and shall comply fully with the NEC.
c. Controller shall be NEMA 4X rated with ambient operating temperature range of -40°F to 140°F and relative humidity range of 0% to 90% non-condensing.
d. Controller shall include local LED indicator lights to indicate when heater is on and when an alarm condition exists.
e. Controller shall include an isolated solid-state triac relay and a dry contact relay for alarm annunciation.
f. Controller shall be provided with Modbus RTU serial communication interface for communication with Division 230900 BMS.
g. Controller shall be capable of detecting and reporting a ground fault, ambient temperature or piping temperature, and system current. Controller shall automatically conduct periodic testing of system for faults and shall alert the BMS when a fault is detected.
h. Controller shall be wired in a single circuit control configuration with the controller mounted in series with the heating cable. Wiring shall be per manufacturer's recommendations.
i. Total heat trace circuit capacity may not exceed the current rating of the heat trace controller.
j. Power Wiring Diagram:



2. Control Methodology:

a. Provide 3-wire 100-ohm platinum resistance temperature detector (RTD) for ambient-sensing control of heat trace system.
b. RTD to be installed in same space as heat traced piping and wired to heat trace controller per manufacturer's recommendations. RTD shall measure ambient air temperature near heat traced piping system. Where system is larger than 75 linear feet, provide two RTDs wired to heat trace controller and mounted at the 1/3 and 2/3 distances of the heat traced piping run.
c. For heat trace installed on fire protection piping systems: Provide wired connection from heat trace controller to fire alarm control panel for alarm indication to fire alarm system. Comply fully with NFPA 13.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Quality Coordination: Where excavation and backfill for mechanical work passes through or occurs in the same area as work specified in Division 2, comply with both the requirements of Division 2 and the requirements of this Section, or whichever is the more stringent (as determined by the Architect/Engineer in cases of conflicting requirements).

B. Inspection:

1. Examine the areas to be excavated, and the conditions under which the work is to be performed.
2. Notify the Architect/Engineer in writing of conditions detrimental to the proper completion of the work.
3. Do not proceed with excavating until unsatisfactory conditions have been corrected.

C. General:

1. Do not excavate for mechanical work until the work is ready to proceed without delay, so that the total time lapse from excavation to completion of backfilling will be minimum.
2. Remove all rock and boulders from excavation before installing mechanical work.
3. Slope sides of excavations as required for stability, or provide necessary shoring.
4. Remove shoring during backfilling.
5. Excavate near large trees (within the drip line) by hand.

    a. Protect the root system from damage or drying to the greatest extent possible.
    b. Maintain moist condition for root system and cover exposed roots with burlap.
    c. Paint root cuts of 1” diameter and larger with asphaltic tree paint.

6. Saw-cut asphalt and concrete surfaces.

D. Existing Utilities: Locate and protect existing utilities and other underground work in a manner which will ensure that no damage or service interruption will result from excavating and backfilling.

E. Depth of Excavation:

1. Depth for Exterior Piping: Except as otherwise indicated, excavate for exterior piping so that the vertical distance between top of piping and finished grade will not be less than that prescribed by code.
2. Excavate for exterior water-bearing piping (water, steam condensate, drainage) so that the vertical distance between top of piping and finished grade will not be less than 5’0” vertical distance below finished grade.

3. Depth for Unsatisfactory Soil Conditions:

    a. Where directed, because of unsatisfactory soil condition at bottom of excavation, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with “squeegee” washed rock, or other approved sub-base material, compacted as directed, to indicated excavation depth.
    b. Where piping crosses over an area more than 5’0” wide, which has been previously excavated to a greater depth than required for the piping installation:

        1) Excavate to undisturbed soil in a width equal to the pipe diameter plus 2’0”.
        2) Install “squeege” washed rock, or 8” courses of approved subbase material; each course compacted to 95% of maximum density, as required to fill excavation and support piping.

    c. Refer to Change Order procedure elsewhere in Contract Documents.

F. Protection:

1. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.
2. Coordinate excavations with weather conditions, to minimize the possibility of washouts, settlements and other damages and hazards.
3. Allow no more than 100 feet between pipe laying and point of complete backfilling.
4. Maintain dry excavations for mechanical work by removing water.

    a. Protect excavations from inflow of surface water.
    b. Pump minor inflow of ground water from excavations.
    c. Protect excavations from major inflow of ground water by installing temporary sheeting and waterproofing.
    d. Provide adequate barriers which will protect other excavations and below-grade property from being damaged by water, sediment or erosion from or through mechanical work excavations.

5. Provide signs, illumination and barricades as necessary to prevent accidents at excavations.
6. Install and operate a well-point dewatering system to maintain ground water at a level approximately 2’0” below mechanical work excavations, until backfilling is completed.

G. Excavated Material:

1. Store excavated material (temporarily) near the excavation, in a manner which will not interfere with or damage the excavation or other work. Do not store under trees (within the drip line).
2. Retain excavated material which complies with the requirements for backfill material.

3. Remove excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material from project site, and dispose of in a lawful manner.
4. Coordinate acceptable stockpiling areas with Owner in advance of excavation.

H. Bedding:

1. Where indicated below, install as bedding material graded sand with 100% passing through a 3/8" sieve, and 0% passing through No. 100 sieve.

    a. Compact by tamping to form a firm base for the work.
    b. Install bedding from six inches below bottom of pipe to six inches above top of pipe.
    c. Provide bedding for:

        1) Wrapped, coated or plastic pipe and tanks.
        2) Piping over six inches, horizontal cylindrical tanks, and similar work.

            a) Shape the subbase to fit the shape of the bottom 90º of the cylinder, for uniform continuous support.

        3) All water and sewer pipe.

2. Where rock is used as sub-base, place 8-mil polyethylene between rock and bedding.
3. Shape sub-bases and bottoms of excavations with recesses to receive pipe bells, flange connection, valves and similar enlargements in the piping systems.

I. Concrete Encasement: Where piping under roadways is less than 2'6" below surface of roadway, or where ductwork is buried below grade:

1. Provide 4" base slab of concrete to support piping and ductwork.
2. After piping or ductwork is installed and tested, provide 4" thick encasement (sides and top) of concrete before backfilling.

    a. Provide external structural reinforcing of all rectilinear cross section ductwork or any ductwork which is less than 18 ga sheet metal (or equivalent) to prevent collapse of ductwork encasement.

3. Provide minimum 2500 psi concrete for encasement and slab.

J. Backfilling:

1. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.
2. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to the required densities.
3. Do not backfill with frozen soil materials.

4. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously.
5. Do not dislocate the work from installed positions.
6. Backfill to elevations matching adjacent grades, at the time of backfilling excavations for mechanical work.
7. Backfill with finely graded sub-base material to 6” above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks.
8. Backfill excavations in 8” high courses of backfill material, uniformly compacted to the densities indicated in Division 2 using power-driven, hand-operated compaction equipment.
9. If densities are not indicated in Division 2, compact to the following percent of maximum per ASTM D1557:

    a. Lawn/Landscaped Areas: 85%.
    b. Paved Areas, Other than Roadways: 90%.
    c. Roadways: 95%.
    d. Floors: 95%.

10. Where compaction tests indicate lower densities of backfill than specified, continue compaction (and re-excavation and backfilling where necessary).

    a. Provide additional testing as directed by the Architect/Engineer.
    b. The allowable density tolerance is not more than one-test-out-of-five failing more than two percentage points below the specified density.
    c. Initial testing is not work of this Section.

11. Where subsidence is measurable or observable at mechanical work excavations during the guarantee period:

    a. Remove the surface (pavement, lawn or other finish).
    b. Add backfill material, compact, and replace the surface treatment.
    c. Restore the appearance, quality and condition of the surface or finish to match adjacent work.
    d. Eliminate evidence of the restoration to the greatest extent possible.

K. Landscape Restoration:

1. Where excavation and backfill for mechanical work passes through or occurs in a landscaped area, repair or replace the landscape work to match the original condition and quality of the work.
2. Comply with the requirements of Division 2 for repair or replacement of work, and for follow-up maintenance on lawns and planting to ensure satisfactory recovery.

L. Pavement Restoration:

1. Where excavation and backfill for mechanical work passes through or occurs in an area of paving or flooring, replace and restore the construction and finish of the paving or flooring to match the original condition and quality of the work.

M. Surface Repairs:

1. The repairing and replacing of previously installed landscape development work, paving, floor slabs and similar finishes occurring in excavated areas shall be provided, but is not included in work of Divisions 21 through 23.

3.2 CUTTING AND PATCHING

A. Refer to Division 1 of the Specifications.

B. General: Provide measurements, drawings and layouts to installers of other work so that required openings may be provided as construction progresses. Any cutting and patching made necessary by failure to provide this information shall be done at no increase in the contract amount.

C. General: All cutting and patching of existing work required for work of Divisions 21 through 23 is included in Divisions 21 through 23.

D. Where possible, mark openings to be cut on existing construction. Otherwise, provide measurements, drawings and layouts to the trade doing the cutting so that openings may be provided as construction progresses.

E. Cutting Concrete:

1. Where authorized, cut openings through concrete for pipe penetration and similar services by core drilling or sawing.
2. Do not cut by hammer-driven chisel or drill.

F. Cutting:

1. Cut openings in accordance with layouts, measurements, or drawings of the Installer of work requiring openings. Cut openings in concrete by core drilling or sawing; not by hammer-driven chisel or drill.
2. Coordinate the location of all openings with structural drawings. Report any discrepancies to Architect. Do not proceed with work until discrepancies have been resolved.
3. Do not endanger or damage other work through the procedures and processes of cutting to accommodate mechanical work.
4. Review the proposed cutting with the Installer of the work to be cut and comply with their recommendations to minimize damage.

5. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

G. Patching:

1. Where patching is required to restore other work because of either cutting or other damage inflicted during the installation of mechanical work, engage experienced craftsmen to complete the patching of the other work.
2. Restore the other work in every respect, including the elimination of visual defects in exposed finishes.
3. All openings in fire rated construction shall be patched and sealed with U.L. approved sealant to maintain the fire integrity of the structure.

H. Perform cutting, and patching required to:

1. Uncover work to provide installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect/Engineers observation of concealed work.

I. Painting: Paint all surfaces marred by cutting and/or patching to match existing.

1. Engage experienced painters.
2. Comply with requirements of Painting Sections of this Specification.

J. Structural Limitations:

1. Do not cut or drill into structural framing, walls, floors, decks, and other members intended to withstand stress, except with Engineer's written authorization.

    a. Provide lintels, columns, braces and other temporary and permanent supports made by cutting.
    b. Submit shop drawings of permanent supports.
    c. Do not penetrate legs of structural "T's" or any other location where pre-stressed structural chords are likely to be encountered when cutting or drilling.

3.3 ACCESS PANELS

A. Furnish access panels where indicated and at locations where required for access to:

1. Concealed valves
2. Dampers
3. Control devices

4. Equipment servicing
5. Shock arresters
6. Air vents
7. Flow measuring and balancing stations
8. Any other device or item equipment requiring maintenance, adjustment or service.

B. Deliver access panels for installation by the trade responsible for surface in which installed.

1. Provide instructions for location.
2. Access doors shall be sized as required to allow equipment removal, with a minimum size of 12”x12”.

3.4 SLEEVES

A. Provide sleeves for piping passing through walls, floors and roofs.

B. Set pipe sleeves and inserts in place before concrete is poured. Coordinate the placing of these items to avoid delaying concrete placing operations.

C. Locate chases, shafts, and openings required for the installation of the mechanical work during framing of the structure. Do any additional cutting and boring required due to improperly located or omitted openings without cost to the Owner under the supervision of the Owner’s representative.

D. Size sleeves for below grade pipe a minimum of 2” beyond outside of pipe.

E. Provide Sleeves as Follows:

Sleeve Location	**Sleeve Material**
Interior Stud Partition Walls	Adjustable galvanized sheet metal with wall flanges and plaster lip, 2” and smaller – 22 gauge, 3” through 6” – 20 gauge, 8” and larger – 18 gauge.
Membrane Waterproof Floor and Roof Construction	Galvanized cast iron body with flashing clamp, threaded for sleeve riser. (J.R. Smith 1760 or equivalent by Ancon, Zurn or Josam).
Nonmembrane Floor, Construction	Non-adjustable galvanized sheet metal with deck flange and end cap, 2” and smaller – 22 gauge, 3” – 20 gauge, 4” and larger – 16 gauge.
Exterior Walls Below Grade	Standard weight galvanized steel pipe with a continuously welded water stop of ¼” steel plate extending from outside of sleeve a minimum of 2” all around. Provide modular mechanical–type seal consisting of interlocking synthetic rubber links with bolts shaped to continuously fill the annular space between the pipe and sleeve. Thunderline Corporation “Link-Seal” sealant assembly or equal by Metraflex “MetaSeal”.

Sleeve Location	**Sleeve Material**
Floors of Mechanical Rooms, Concrete Walls or Masonry Walls Above Grade.	Standard weight galvanized steel pipe.

F. Length of Sleeves as Follows:

Location	**Sleeve Length**
Floors	Equal to depth of floor construction including finish. Extend minimum of 1" above finished floor level within partitions, mechanical rooms, pipe chases and finished areas.
Roofs	Equal to depth of roof construction including insulation.
Walls	Equal to depth of construction.

3.5 FIRE STOPPING

A. Install firestopping materials in accordance with their UL and ASTM tested methods.

B. Coordinate required annular space with size of pipe and sleeve. Refer to Section 23 05 22.

C. Requirements for specific systems:

1. Cold piping - includes chilled water, domestic water, storm water and refrigerant: Insulation and vapor barrier shall be continued through wall and firestopping for "insulated piping" shall be provided.
2. Hot piping - to 250ºF -includes domestic hot water, steam to 15 psig and heating hot water: The Contractor has the option of continuing the insulation through the penetration and providing firestopping for "insulated piping", or stopping the insulation on either side of the penetration and using firestopping for "uninsulated piping".
3. High temperature piping, over 250ºF or over 15 psig steam: Contractor shall stop insulation and provide firestopping for "high temperature piping".

3.6 HEAT TRACE

A. Furnish and install a complete electric heating cable system as indicated on the mechanical and plumbing drawings.

B. Heat trace cable shall be installed by a licensed electrician.

C. Heat trace systems shall be installed per manufacturer's requirements in order to maintain system agency listings.

D. Minimum installation temperature shall be 0°F. Do not apply heat trace when pipe temperature, roof temperature, gutter temperature, or downspout temperature is below 0°F.

E. Apply the heat trace cable on the pipe after pressure testing.

1. Do not spiral wrap on pipe.
2. Make one wrap at valves.
3. Secure to pipe with methods approved by manufacturer.

F. Apply “Electrically Traced” signs on outside of insulation for heat traced piping. Provide one sign for every 10’ of pipe length.

G. Heating cable circuit integrity shall be tested using a 2500 VDC megohmmeter at the following intervals. Minimum acceptable insulation resistance shall be 1000 megohms or greater.

1. Before installing the heating cable
2. After heating cable has been installed onto the pipe
3. After installing connection kits
4. After the thermal insulation is installed onto the pipe
5. Prior to startup

H. Heat trace shall be sized based on the application, and power shall be provided in accordance with manufacturer’s recommendations for circuit quantity and power distribution.

I. Do not locate heat trace controllers in Class 1, Division 2 hazardous areas.

J. Startup shall be conducted by manufacturer’s representative.

3.7 EQUIPMENT BASES AND SUPPORTS

A. Supporting Steel: Provide supporting steel not indicated on the Structural Drawings for equipment, pipe, ductwork, and other pieces of this Division’s work requiring same.

1. Submit shop drawings and structural calculations to the Engineer for information and records.
2. Brace and fasten with flanges bolted to structure.
3. Paint supporting steel with one coat of primer paint in the shop after fabrication welding is complete. Paint completed field joints with one coat of matching primer.

3.8 DRIP PANS

A. Drip Pans: Where possible to run mechanical piping elsewhere, do not run mechanical piping directly above electrical (or electronic) work which is sensitive to moisture. Otherwise, provide drip pans under mechanical piping, sufficient to protect electrical work from dripping.

1. Locate pan immediately below piping, and extend a minimum of 6” on each side of piping and lengthwise 18” beyond equipment being protected.
2. Fabricate pans 2” deep of reinforced sheet metal with rolled edges and soldered or welded seams; 22-gauge galvanized steel.

3. Provide ¾" copper drainage piping from pan to nearest floor drain or similar suitable point of discharge, and terminate pipe as an open-sight drainage connection.
4. Provide permanent support and anchorage to prevent displacement of drip pans.
5. Insulate bottom of pan as directed by Engineer.

END OF SECTION 23 05 03

SECTION 23 05 21 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Welder Qualifications: Welders, both on-site and off-site, shall be certified for the type of work being performed by one of the following:

1. National Certified Pipe Welding Bureau.
2. Intermountain Testing Company

B. Welder Certificates:

1. Submit one copy of certificate to Architect/Engineer.
2. Maintain one copy on project site.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Refer to the following sections:

1. 22 21 23 - Natural Gas Piping
2. 23 21 13 - Hydronic Piping
3. Other Divisions 21 through 23 sections after specific system requirements.

2.2 GROOVED PIPE COUPLING SYSTEMS

A. Manufacturers of Coupling System:

1. Basis of Design: Victaulic
2. Other Acceptable Manufacturers: Grinnell and Gruvlok. Alternate is to provide a system of standard weight black steel pipe with black steel standard weight butt weld or 125 lb. cast iron flanged fittings.
3. All couplings, gaskets and joining method adapters shall be provided by one manufacturer.
4. Training: A factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and product installation.

B. Dimensional Standards:

1. All grooved pipe fittings, couplings, and specialties shall conform to standard dimensional standards ANSI/ANWA C-606 or MIL-P-11087C.

C. Acceptable Products:

1. Only the following grooved pipe products may be used:

a. Gaskets: (ASTM D2000) EHP, for water service, with or without propylene glycol -30ºF to 250ºF, primary seal by compression of coupling housing, either pressure or vacuum shall assist in sealing force.
b. Couplings - Steel Pipe: Ductile iron (ASTM A-536) or malleable iron (ASTM A-47), with enamel paint coating.

1) Rigid Couplings: Style 107, 07, W07 zero flex.
2) Flexible Couplings: Style 177, 77, W77.

c. Flange Adapters: Same materials as couplings. Provide for rigid connection to grooved pipe. Provide flange washers and/or flange gaskets as required for mating to non-standard flanges, such as butterfly valves with elastomeric face, or serrated face flanges.

1) ANSI Class 125 or 150: Style 741.
2) ANSI Class 300: Style 743.
3) Alternate to flange adapter: Flange by groove nipple #41 (Class 125), #45 (Class 150), #16 (Class 300).

d. Branch Outlet Couplings: Design similar to coupling with integral side outlet.
e. Fittings for steel pipe: Standard pattern fittings, ductile iron (ASTM A-536), malleable iron (ASTM A-47) or segmentally welded Schedule 40 steel (ASTM A-53) with enamel paint coating. All changes in direction greater than 22º shall be with R=1.5D radius elbow. All branches and changes in direction in drainage piping shall be made with sanitary type lateral branches and R=1.5D elbows.
f. Accessories: Other piping accessories such as strainers, suction diffusers and flow indicators may be provided with grooved ends, all such accessories shall comply with the applicable specification section.

2. All other pipe products shall conform to the requirements of other Divisions 21 through 23 sections. Acceptance of grooved pipe systems does not imply acceptance of the coupling manufactures valves, branch outlets, strainers, or other specialties.

2.3 PRESS FIT JOINING SYSTEM

A. Manufacturer

1. Viega ProPress
2. Nibco Press System
3. Other approved manufacturer

B. Material

1. Press Fittings: Copper press fittings. Must comply with ASME B16.18 or B16.22.
2. O-Rings: EPDM
3. Fittings shall be rated for 0°F to 250°F, and 200 psi.

C. Application

1. Domestic Water, 4” and smaller
2. Hydronic Systems, 4” and smaller

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. General:

1. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure.
2. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly, maintenance or replacement of valves and equipment.
3. Reduce sizes by use of reducing fittings.
4. Install piping without springing or forcing.
5. Provide sufficient swing joints, anchors, expansion loops and devices necessary to permit free expansion and contraction without causing undue stresses.
6. Support piping independently at equipment so its weight will not be supported by the equipment.
7. Support piping to maintain a consistent slope as indicated on the drawings without sagging or pocketing of any kind. Where not otherwise indicated, all horizontal piping shall slope a minimum of 1/16 inch per foot to drain at system low points.
8. Provide manual air vents at high points of all pumped piping systems. Provide drains at all low points.
9. Install horizontal piping parallel to building construction, make any changes in direction with fittings.

B. Location:

1. Locate piping runs, except as otherwise indicated, both vertically and horizontally to allow for complete drainage of piping system (pitched to drain).

    a. Avoid diagonal runs wherever possible.
    b. Orient horizontal runs parallel with walls and column lines.

2. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of the building.

    a. Limit clearance to 0.5” where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any.
    b. Where possible, locate insulated piping for 1.0” clearance outside insulation.

3. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings.

    a. Do not encase horizontal runs in solid partitions, except as otherwise indicated.

C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures.

1. Exception: where shown on drawings or where accepted by the Engineer, provide drip pan under piping, and conform to NEC.
2. In no case shall piping run directly above transformers, electrical panels or switchgear.

D. Dielectric Unions: Install dielectric unions to prevent galvanic action between ferrous and non-ferrous piping.

1. Install in an accessible location or provide access doors.

3.2 PLASTIC PIPE

A. Use:

1. Contractor shall take full responsibility that the plastic piping used and its installation meets with the approval of the local authorities.
2. Pipe shall be insulated in air plenums such that the entire installation meets ASTM E84 (NFPA 255) with regard to flame spread and smoke developed ratings suitable for plenum installation.
3. Provide pipe with U.V. inhibitors or paint (under Division 9):

    a. For all plastic pipe exposed to sunlight or installed in exterior, exposed locations.
    b. Store PVC without inhibitors indoors.

3.3 WELDING

A. Welding:

1. Conform to Code for Pressure Piping ANSI B31.
2. Machine cut and bevel piping ends for v-type joints.
3. Use recommended bevels and spacing between ends of pipe to assure full penetration complete to inside diameter of pipe.

B. Welded Joints:

1. Will be observed visually by the Architect/Engineer.
2. Any weld judged defective from a visual observation, shall be ordered tested at the expense of the Contractor or chipped out for full depth and re-welded.

C. Welding Fittings:

1. Unless otherwise noted, make all changes in direction and branch take offs with manufactured fittings.

    a. Use long radius (R=1.50) fittings wherever possible.

2. Shop Fabricated Fittings:

    a. Branches more than two pipe sizes smaller than main line may be made with "weld-o-let" type pre-manufactured saddle fittings.
    b. Where specifically allowed by the Engineer, angles of less than 22½º and branch piping from headers may be made by shop fabricated or manufactured metered fittings.
    c. Submit shop drawings.
    d. Thoroughly clean fittings to remove slag.
    e. Fittings shall be available for observation by the engineer prior to installation.

3. In no case will field made miters or weld-o-let fittings be allowed. Exception: Temperature control wells and water treatment taps may be made with weld-o-let fittings in pipe 3" or larger in diameter.

3.4 COPPER TUBING JOINTS AND FITTINGS

A. Unless otherwise noted, make all couplings, changes in direction, branch outlets, and transitions to other materials or joining methods with standard manufactured fittings.

B. Do not expand or swage piping in lieu of proper solder fittings.

C. Do not extrude or "pull" branch outlets with "tee-drill" type equipment.

D. Do not use self-tapping type branch outlets.

1. See “hot taps” below.

3.5 THREADED JOINTS AND FITTINGS

A. All threaded joints shall be made in accordance with American National Standard B2.1.

1. Do not overthread pipe.
2. Apply pipe joint compound on male threads only.
3. Do not use right and left hand threaded joints to make a “union”.

B. Do not thread steel pipe schedule 10 or lighter.

1. UL listed light wall pipe may be threaded in accordance with its listing.

3.6 MECHANICAL COUPLING SYSTEMS

A. All changes in direction shall be made with radius type elbows.

1. Use long radius (R=1.5D) fittings wherever possible.
2. Angles less than 22½º may be made with pre-manufactured metered fittings.
3. Use of the angular deflection capabilities of grooved pipe couplings for intentional changes of direction shall not be allowed.

B. All branch outlets shall be made with pre-manufactured 3-way fittings.

1. Shop fabricated Weld-o-let style welded saddle fittings may be used for branches more than two pipe sizes smaller than the main.
2. Mechanical saddle tap fittings shall not be allowed.

C. Pipe shall be adequately laterally supported to prevent “pipe squirm”. Provide a minimum of one hanger per pipe section. No pipe section shall be left unsupported between any two couplings.

1. Rigid type couplings may be considered equivalent to welded or soldered pipe for the above requirements.

D. Risers more than 20’ high shall be made with rigid type couplings.

E. Grooved pipe systems shall not be considered to be electrically conductive.

1. Provide wire jumpers across all couplings where the piping system is required to be electrically conductive.

2. Cold water piping using grooved pipe systems shall not be used for building ground.

    a. Provide an engraved plastic sign at the building water entrance stating, “Mechanical Coupling System”. Not Electrically Conductive”.

F. Flexible couplings may be used for thermal expansion/contraction compensation.

1. Use a minimum of 1 flexible coupling for every 100 feet for condenser water.
2. The above is for cut grooved pipe. Double the amount of the connectors with roll grooved pipe and fittings.

3.7 PRESS FIT SYSTEMS

A. Fittings and piping shall be joined in accordance with manufacturer’s installation guidelines.

1. Tubing shall be fully inserted into fitting.
2. Mark all tubes at shoulder of fitting.
3. Press joints using manufacturer approved tool.

3.8 HOT TAPS

A. Installing a branch line in piping while under service or static pressure (hot taps) shall only be done where specifically authorized.

B. Submit the proposed method of procedure for each fluid service and pipe material.

1. Hot tap procedure shall remove a plug of main tap material and retrieve it. The plug shall be a maximum of 1 pipe size smaller than the branch size. Hang the removed plug by a chain at the completed tap.
2. Hot tap procedure shall not affect the temperature or pressure rating of the piping system.
3. Hot tap procedure shall be done through a gate or ball valve.

3.9 SENSOR WELL TAPS

A. Sensor wells shall be placed in taps made in accordance with the above requirements for branch outlets.

3.10 CLEANING, FLUSHING, INSPECTING

A. Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings, if any.

B. Flush out water and piping systems with clean water before proceeding with required tests.

C. See specific pipe service section for further requirements.

3.11 PIPING TESTS

A. Provide temporary equipment for testing, including pump, thermometer and gauges.

B. Test piping system before insulation is installed wherever feasible, and remove control devices before testing.

C. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating.

D. Fill each section of water, drain or vent piping with water and pressurize for two hours at 150% of operating pressure, but not less than 25 psig for pressure piping, and ten feet of head for drain and vent piping.

E. Test fails if leakage is observed, or if temperature compensated pressure drop exceeds 1% of test pressure.

F. Disassemble and re-install sections which fail the test by using new materials to the extent required to overcome leakage.

1. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

G. After testing and repair work have been completed, drain test water from piping systems.

3.12 PLASTIC PIPING

A. Do not test with air pressure.

B. Provide mineral wool fire blanket and tape sealant system to protect all plastic pipe in a return air system.

C. Support all plastic piping in anticipation of 120ºF pipe temperature.

3.13 PAINTING

A. Exposed piping shall be painted. Pipe shall be cleaned by this contractor and ready for priming and painting. Painting to be by Architectural divisions.

END OF SECTION 23 05 21

SECTION 23 05 22 - PIPING ACCESSORIES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Manufacturer's Data - Piping Accessories: Submit manufacturer's data on the following piping accessories:

1. Sealing compound for sleeves.
2. Expansion compensators.
3. Flexible pipe connections.
4. Guides.

PART 2 - PRODUCTS

2.1 MANUFACTURED PRODUCTS

A. Escutcheon Plates:

1. Type: Split ring
2. Construction: Brass
3. Finish:
    a. At Painted Surfaces: Prime coat
    b. At Other Surfaces: Nickel or Chrome plate
4. For Floor Sleeves: Where sleeves extend above floor surface, provide depth to cover sleeve.

B. Flexible Pipe Connectors, Rubber Type:

1. Manufacturers - Design Basis: Mason
2. Other Acceptable Manufacturers:
    a. Flexicraft
    b. Keflex
    c. Metraflex
3. Material: Two sphere EPDM construction with reinforcing ring.
4. Model: MFTNC, Twin Sphere 225 psi.

C. Flexible Pipe Connectors, Braided Hose:

1. Manufacturers - Design Basis: Mason
2. Other Acceptable Manufacturers:

   a. Flexicraft
   b. Keflex
   c. Metraflex

3. Material: Stainless steel braid with carbon steel connectors, threaded or flanged.

2.2 FABRICATED ACCESSORIES

A. Steel-Pipe Sleeves: Fabricate from Schedule 40 steel pipe. Remove burrs.

B. Iron-Pipe Sleeves: Fabricate from service weight cast-iron pipe. Remove burrs.

C. Sheet-Metal Pipe Sleeves: Fabricate from galvanized sheet-metal, closed with lock-seam joints.

1. For following pipe sizes, provide gauge indicated:

   a. Three-Inch Pipe and Smaller: 20 gauge
   b. Four-Inch to Six-Inch Pipe: 16 gauge
   c. Over Six-Inch Pipe: 14 gauge

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipe Sleeves:

1. Install pipe sleeves where piping passes through walls, floors, ceilings, roofs and structural members, except soil pipe penetrations through concrete slab on grade.
2. Where possible pour sleeve in place or grout.
3. Provide sleeves of adequate size, accurately centered on pipe runs, so that piping and insulation (if any) will have free movement in the sleeve in non-fire rated penetrations.
4. In fire rated penetrations, size sleeves such that the resulting annular space is in accordance with the application requirements of the fire stopping system. Refer to Section 23 05 03. All above grade floor penetrations shall be considered to be fire-rated.
5. Install length of sleeve equal to thickness of construction penetrated, except extend floor sleeves 0.25” above floor finish and, where floor surface drains to a floor drain, extend floor sleeve 0.75” above floor finish.
6. Provide temporary support of sleeves during placement of concrete and other work around sleeves.

7. Provide temporary closure to prevent concrete and other materials from entering pipe sleeves.
8. Except as otherwise indicated, install steel pipe sleeves.
9. At interior partitions and ceiling, install sheet metal sleeves.
10. At exterior penetrations below grade, install iron pipe sleeves.
11. Seal exterior sleeve penetrations at grade weather tight.

B. Caulking:

1. Where water seal or sound seal, but not fire seal, is needed, (foundation walls, slab on grade): fiberglass backing and heavy bead of silicone caulking compound.
2. Where sleeve pierces a fire separation: Fire stop material in accordance with manufacturer's directions and UL listing. Refer to Section 23 05 03.

C. Install escutcheon plates at pipe sleeves where piping is exposed to view in occupied spaces of the building, on the exterior, and elsewhere as indicated.

D. Compensators: Install where shown or where required because piping arrangement does not provide sufficient flexibility.

1. Protect compensators from over-travel and over-stress during remaining installation and testing.

E. Flexible Connectors: Install at right angles to displacement.

1. Install one end immediately adjacent to isolated equipment and anchor other end.

F. Guides: Install where shown and where required in accordance with expansion compensators published requirements.

1. As a minimum, install one guide within four pipe diameters of compensator, and one guide 14 pipe diameters from first guide.

END OF SECTION 23 05 22

SECTION 23 05 23 - VALVES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's product data including:

1. Dimensions
2. Sizes
3. End Connections
4. Weights
5. Installation instructions
6. Instructions on repacking and repairing valves.
7. Range of flow and full open (permanent) pressure loss for balancing valves and plug valves.
8. Differential pressure tables for flow measurement at venturi type balancing valves.

B. Valve Tag List: Refer to Section 23 05 53 of the Specifications.

PART 2 - PRODUCTS

2.1 VALVES TYPES AND SIZES

A. General:

1. Where type or body material is not indicated, provide valve with pressure class selected from MSS or ANSI standards, based on the maximum pressure and temperature in the piping system.
2. All valves in contact with domestic water shall meet the requirements of NSF/ANSI Standard 61.
3. Except for balancing or otherwise indicated, provide valve of same size as connecting pipe size.
4. Ball valves or butterfly valves may be used in lieu of gate valves when pressure and temperature ratings are adequate.
5. Where pipe sizes overlap, contractor has the option of threaded or flanged valves.
6. Where grooved pipe mechanical coupling systems are accepted, provide flange adapters to mate with valves as specified below. Valves by the mechanical coupling system manufacturer shall not be used unless they meet all of the specified requirements for a given valve.
7. All valves shall be domestically manufactured unless approved for use by Engineer.

8. Valves used for domestic water service shall be bronze or stainless steel. Iron and brass body valves are not acceptable.
9. All components in hydronic systems shall be compatible with propylene glycol and water solution.

B. Unless noted otherwise, the following table indicates valve types to be used for functions listed. Manufacturer listed is basis of design. Refer to specification section indicated for additional requirements.

Service	Condenser Water	Domestic Hot and Cold Water
Shutoff/ Isolation	2-1/2" and larger: • Type BTV Butterfly Valve 2" and smaller: • Type BV Ball	All sizes • Type BV Ball RE: 221000 Plumbing Piping
Check	2" and larger: • Type SWCV Silent/Wafer Check 1-1/2" and smaller: • Type SCV Swing Check	2" and larger: • Type SWCV Silent/Wafer Check 1-1/2" and smaller: • Type SCV Swing Check RE: 221000 Plumbing Piping
Balance	2-1/2" and larger: • Type BLV Manual 2" and smaller: • Type BLV Manual	All sizes • Type CS Circuit Setter RE: 221000 Plumbing Piping
Base Mounted Pump Discharge	All sizes: • Type TCS Combination Throttling/ Check Valve	N/A
Inline Pump Discharge	All sizes: • Type SWCV Silent/Wafer Check	All sizes: • Type SWCV Silent/Wafer Check
Drain Valve	All sizes: • Type BV Ball	All sizes: • Type BV Ball
Bypass	RE: Shutoff/Isolation	RE: Shutoff/Isolation RE: 221000 Plumbing Piping

1. Refer to section 22 10 00 Plumbing Piping for additional Domestic Water valve specifications and requirements.
2. Refer to Division 22 specifications for additional system valves and specialties not indicated in table above.

2.2 GLOBE AND ANGLE VALVES – TYPE GAV

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:

    a. Crane
    b. Gruvlok
    c. Nibco
    d. Powell
    e. Stockham
    f. Victaulic (for Grooved Pipe Systems)

B. Size 2” and Smaller: Bronze, 125 psi SWP, 200 psi WOG, rising stem, screwed bonnet. Bronze disk, MSS SP-80, Type 1.

1. Model:

a. Globe, Solder Ends: 1502
b. Globe, Threaded Ends: 502
c. Angle: 504

C. Size 2½” and Larger: 125 psi SWP, 200 psi WOG, OS&Y bolted bonnet, gland packed, bronze disk, removable bronze seat ring, MSS SP-85.

1. Model:

a. Globe: F-2981

2.3 SWING CHECK VALVES – TYPE SCV

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:

a. Crane
b. Gruvlock
c. Nibco
d. Powell
e. Stockham
f. Victaulic (for Grooved Pipe Systems)

B. Size 2” and Smaller: Bronze, 200 psi SWP, 400 psi WOG, straight or Y-pattern, Bronze Disk, MSS-SP80 Type 3.

1. Model: 508

C. Valves used for domestic water service shall be ANSI/NSF-61 certified.

2.4 SILENT/WAFER CHECK VALVES – TYPE SWCV

A. Manufacturers:

1. Design Basis: Metra Flex
2. Other Acceptable Manufacturers:

a. Cla-Val
b. GA Industries

c. Gruvlok
d. Nibco
e. Stockham
f. Tyco
g. Victaulic (for Grooved Pipe Systems)

B. Size 2” and Smaller: Bronze body, 200 psi @ 250 °F, threaded ends, resilient seats, center guided disk.

1. Model: 5700

C. Pipe size 2 1/2 “ and Larger: Iron body, bronze or stainless-steel trim, class 125, 316 stainless-steel spring, dual plate or tilting disk type, resilient seat, minimum C_V: 4”-280, 8”-1200, 12”-4000.

1. Model: 810

D. Valves used for domestic water service shall be ANSI/NSF-61 certified.

2.5 BUTTERFLY VALVES – TYPE BTV

A. Manufacturers:

1. Design Basis: Keystone
2. Other Acceptable Manufacturers:

a. Bray
b. Center Line
c. Crane
d. Gruvlok
e. Hammond Watts
f. Keystone
g. Milwaukee
h. Nibco
i. Stockham
j. Victaulic (for Grooved Pipe Systems)

B. Water Service (less than 250ºF): 200 psi WOG, cast or ductile iron fully lugged body, integral extended neck to clear insulation, integral top plate for actuator mounting, stainless-steel stem, upper and lower lubricated bushings, field replaceable hard back seat with integral stem and flange seals, machined disk seating areas, rated for minimum 150 psi dead end service with no downstream flange. Liner to be compatible with operating fluid. Conform to MSS-SP67.

1. Disk Material - 8” and Under and all sizes for condenser or domestic water: Aluminum bronze.

2. Disk Material, 10” and Larger: Nickel plated ductile iron.
3. Model: Figure 2-22.

C. Accessories:

1. 10 position locking lever handler for valves 6” and smaller.
2. Infinite position memory stop lever handle for all valves 6” and smaller used for balancing.
3. Hand wheel gear operator for valves 8” and larger.
4. Chain wheel operator where required.

2.6 GATE VALVES – TYPE GTV

A. Manufacturers:

1. Design Basis: Milwaukee
2. Other Acceptable Manufacturers:

    a. Crane
    b. Gruvlok
    c. Nibco
    d. Stockham
    e. Victaulic (for Grooved Pipe Systems)

B. Size 2” and Smaller: Bronze 125 psi SWP, 200 psi WOG, rising stem, threaded bonnet, gland packed MSS SP-80 Type 2.

1. Model: 148

C. Size 2½” and Larger: Cast iron, 125 psi SWP, 200 psi WOG, gland packed, bolted bonnet, OS&Y, solid wedge disk, either all bronze or with bronze face ring, bronze seat rings, brass back seat bushing, brass stem, bronze yoke bushing.

1. Model: F2885

2.7 BALL VALVES – TYPE BV

A. Manufacturers:

1. Design Basis: Nibco
2. Other Acceptable Manufacturers:

    a. Apollo
    b. Bray
    c. Dyna Quip
    d. Gruvlok

e. Hammond
f. Milwaukee
g. Stockham
h. Victaulic (for Grooved Pipe Systems)
i. Watts

B. Valve bodies must be cast bronze. Forged brass is not acceptable.

C. Bronze, 150, SWP, 600 WOG (min), chrome plated solid, tunneled bronze ball (stainless for steam service), two-piece design, blow-out proof stem, adjustable packing gland nut (allowing handle to be removed without leaking) TFE seats, MSS-SP-110.

1. Model: T-585-70 - full.port.

D. Valves used for domestic water service shall be ANSI/NSF-61 certified.

E. Options: Provide the following where required:

1. Extended stems for insulated valves.
2. Memory stop device for balancing applications.
3. Tee handle for tighter areas.
4. Hose end and cap for drain.
5. Mounting pads for actuator.

2.8 CIRCUIT SETTERS (CS) – DOMESTIC WATER APPLICATIONS ONLY – TYPE CS

A. Manufacturers:

1. Design Basis

a. Bell & Gossett/ITT

2. Acceptable Manufactures:

a. Victaulic
b. Prior Engineer Approval for Substitutions

B. Construction:

1. All valves to be of brass body/brass ball construction with glass and carbon-filled TFE seat rings. Valves to have differential pressure read-out ports across valve seat area. Read-out ports to be fitted with internal EPT insert and check valve. Valve bodies to have ¼" NPT tapped drain/purge port. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. All valves to have calibrated nameplate to assure specific valve setting. Valves to be leak-tight at full rated working pressure.

C. Valves ½" to 2" pipe size, NPT or sweat valves 2 ½' and 3" pipe size, NPT.

D. Pressure/Temperature 175 psig at 250°F.

E. ANSI/NSF-61 certified.

2.9 COMBINATION THROTTLING/CHECK VALVES – TYPE TCS

A. Manufacturers:

1. Basis of Design: Bell & Gossett Triple Duty Valve.
2. Other Acceptable Manufacturers:

    a. Armstrong
    b. Taco
    c. Victaulic (for Grooved Pipe Systems)
    d. Watts

B. Features:

1. 175 psi, 250ºF water working pressure.
2. Globe style valve with stainless-steel spring-loaded brass disk guided and limited by a brass or stainless-steel stem.
3. Resilient seat.
4. Able to be re-packed under pressure.

2.10 DRAIN VALVES – TYPE DV

A. Ball valve with hose end adapter and cap.

2.11 PLUG VALVES – TYPE PV

A. Manufacturers:

1. Design Basis: Keystone
2. Other Acceptable Manufacturers:

    a. Dezurik

B. Model: "Ballcentric"; cast-iron, full port body; EPDM coated plug; welded nickel seat; stainless-steel bearings; integral memory stop device; hand wheel operator for valves 6" and larger.

2.12 BALANCING VALVES – TYPE BLV

A. Manufacturers:

1. Design Basis: IMI Hydronic Engineering (Flow Design).
2. Other Acceptable Manufacturers:

    a. Armstrong
    b. Griswold
    c. Hays
    d. Nexus
    e. Nibco
    f. NuTech
    g. Tour and Andersson

B. Manual Balancing Valves (1/2" through 2"):

1. 400psi at 250°F, venturi type, with integral ball valve, brass body, EPDM O-ring seals, two pressure/temperature ports, and manual air vent. Memory stop with graduated markings. PTFE ball valve seats with blowout proof stem. Soldered or threaded connections.
2. Each valve shall provide four (4) functions:

    a. Precise flow measurement
    b. Precision flow balancing
    c. Positive shut-off with no drip seat, eliminating the need of an additional isolation valve.
    d. Manual air venting.

C. Balancing Valves (2-1/2” - 16"):

1. 240 psi at 250°F, venturi type, with integral butterfly valve, steel body, and two pressure/temperature ports. Flanged connections.
2. Butterfly valve: 200 psi WOG, cast or ductile iron fully lugged body, lever handle, infinite position adjustment, memory stop, integral extended neck to clear insulation, stainless-steel stem, upper and lower lubricated bushings, field replaceable hard back seat with integral stem and flange seals, machined disk seating areas, rated for minimum 150 psi dead end service with no downstream flange. Liner to be compatible with operating fluid. Conform to MSS-SP67.
3. Butterfly Valve Disk: Aluminum Bronze.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with the following requirements:

1. Install valves except butterfly with stems pointing up, and as close to vertical as possible. Butterfly valves to be offset at least 10° from vertical.
2. Install valves at each piece of equipment, fixture or appliance so that the supply and return services can be shut off to remove the item without draining the remainder of the piping system.
3. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping.

    a. Locate valves so as to be accessible.

4. Combination balancing and shut-off valves may be used instead of a separate balancing valve and shut-off valve if the valve has a memory stop and the manufacturer lists its use as a leak-proof service valve.
5. Provide drain valves at main shut-off valves, low points of piping and apparatus.
6. Provide separate support where necessary.
7. Do not allow meter connections of balancing valves to point downward.
8. Install valves so bypass valves are accessible.

B. All valves of a given type shall be of one manufacturer.

C. Provide extended stems on insulated system to prevent interference of operator with insulation.

3.2 CHECK VALVE INSTALLATION

A. Swing and Check Valves:

1. Install only in horizontal lines unless absolutely impractical. If installed vertically, flow shall be upwards.
2. Do not install in pump discharge piping.

B. Silent Check Valves:

1. Silent check valves may be installed in vertical pipes with flow down upon Engineer's review for each instance.

3.3 VALVES USED FOR THROTTLING/BALANCING

A. Throttling/Balancing Valves shall be selected so that the maximum design flow causes between 1' and 10' W.G. pressure drop or meter reading with the valve wide open.

B. Install balancing valves used for flow indication with a minimum of five times the pipe diameter downstream and two times the pipe diameter upstream of a fitting or valve.

C. Globe, ball, butterfly, or plug valves may be used for throttling/balancing. Provide an infinitely variable, lockable memory stop device to allow the valve to be returned to the "balanced" position after closing, and to prevent movement of the disk or plug during operation. When ball valves are used for throttling, provide an additional valve for equipment isolation.

D. Balancing valve sized to flow.

E. Insulation: Provide pre-molded insulation conforming to the valve body. Material shall have a flame spread of 25 and a smoke development of 50.

3.4 COMBINATION THROTTLING/CHECK VALVES

A. Combination throttling/check valves may be used in lieu of separate throttling and check valves on pump discharge piping. However, they may not be used for flow measurement.

3.5 CIRCUIT SETTERS

A. All circuit setters shall be installed per manufactures recommendations. Provide manufacturers recommendation for required straight pipe for inlet and outlet connections to provide accurate ratings. Setting shall be 1 GPM unless otherwise noted on drawings.

END OF SECTION 23 05 23

SECTION 23 05 29 - PIPE SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 STANDARDS

A. ASME B31.1 (American Society of Mechanical Engineers) – Power Piping.

B. Comply with MSS Standard Practice SP-69, published by Manufacturer's Standardization Society of the Valve and Fitting Industry for type and size.

C. NFPA 13 2010 (National Fire Protection Association) – Installation of Sprinkler Systems.

D. UPC 2012 (Uniform Plumbing Code) – Defines support spacing of hangers

1.2 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Hangers other than clevis type.
2. Anchors.

B. Submit structural calculations on trapeze type supports.

C. Submit product data and calculations to project structural engineer for review. Submittals shall document compliance with current Building Codes and maximum point loads listed in Structural plans.

PART 2 - PRODUCTS

2.1 PIPE HANGERS

A. General:

1. Use adjustable pipe hangers on suspended pipe. Trapeze hangers may be used at the Contractor's option. Contractor shall be responsible for sizing supports.
2. Chain, wire or perforated strap hangers will not be permitted.
3. Isolate hangers in contact with dissimilar materials with dielectric hanger liners. Tape is not acceptable.
4. Provide supports between piping and building structure where necessary to prevent swaying.

B. Hanger and Rod Material:

1. Exposed in public areas: Zinc electroplated steel.
2. Concealed or in service areas: Black threaded steel.
3. Outside, exposed to weather: Hot dipped galvanized.
4. Buried below structural slab: Stainless Steel

C. Cast-In- Place Inserts:

1. Cast-in-place inserts system shall be used.
2. Inserts to be UL and FM listed for their application.
3. Cast-In-Place Anchors shall be designed per ACI 318 Appendix D Strength Design methods as required by the IBC 2012 and ASCE 7-10. Where exempt from ACI 318 Appendix D, anchors shall be designed using Allowable Stress Service loads if allowed by the Building Code.
4. Cast In Place inserts shall be tested in accordance with current ICC-ES acceptance criteria A.C. 446 or ACI 355.2 where required.
5. Cast In Place inserts in concrete shall have a current ICC-ES or IAPMO-UES listed Research Report. Anchors shall be installed in strict accordance with approved ICC-ES or IAPMO-UES Research Report for the specific anchor used.
6. Threaded Inserts shall conform to ASTM A307.
7. Size inserts to match size of threaded hanger rods.
8. Manufacturers:

    a. DEWALT Bang-It+, Wood-Knocker II+, or DDI+
    b. Hilti KCM WF or KCM MD
    c. Simpson Blue Banger Hanger

D. Channel Type Inserts:

1. Standard channel support with anchor tabs on 4” centers, and nail holes for attaching to forms.
2. Styrofoam inserts to prevent wet concrete seepage.
3. Minimum 2000 pounds/foot capacity.

E. Expansion, Screw, or Drop-In Anchors:

1. For use only where modifications to piping layouts to change from pre-installed insert locations and only under approval from the Engineer.
2. Inserts shall be wedge-type or screw type and shall be designed per ACI 318 Appendix D Strength Design methods as required by the IBC 2012 and ASCE 7-10. Anchors shall be tested in accordance with current ICC-ES acceptance criteria A.C. 193 or ACI 355.2. Anchors in concrete shall have a current ICC-ES or IAPMO-UES listed Research Report. Anchors shall be installed in strict accordance with the approved ICC-ES or IAPMO-UES Research Report for the specific anchor used.

3. Manufacturers:

    a. DEWALT Power-Stud+ SD2 or Screw-Bolt+
    b. Hilti Kwik-Bolt TZ
    c. Hilti KWIK HUS EZ
    d. Hilti KWIK HUS EZ I
    e. Hilti HDI P TZ
    f. Simpson Strong Bolt 2 or Titen HD Rod Hanger

4. Power driven fasteners are not acceptable.
5. All Drop-in type anchors must be approved for cracked concrete.
6. Anchors shall be installed with all required nuts, washers.
7. Install anchors per Manufacturer's recommendations with proper torque values where required.
8. Interior: Carbon steel anchors complying with ASTM A307.
9. Exterior or Wet Environment: Series 300 stainless-steel anchors, nuts and washers.
10. Anchors shall comply with loading requirements as designated by the Engineer of Record or per the Building Code.

F. Steel Structure Attachments:

1. Contractor may select welded or mechanically attached. All mechanically attached supports shall have jam nuts or other means to prevent loosening. Maximum loading requirements are as follows:

Rod Size	**Maximum Working Load**
3/8	600 pounds
1/2	1100 pounds
5/8	1800 pounds
3/4	2700 pounds
7/8	3700 pounds

G. Single Hangers:

1. Piping 2" and smaller: MSS type 1, Clevis hanger or type 7 adjustable swivel ring hanger. Minimum 180 pounds design load.
2. Piping 2½" and larger: MSS type 1 Clevis hanger.
3. Bare copper pipe: Above hangers, plastic or Neoprene coating, sized for copper pipe O.D. and copper coated for identification.
4. Insulated pipe: Hangers to be sized for O.D. of insulation. Hangers shall not penetrate any insulation.

H. Trapeze hangers and wall supports:

1. Channel strut or structural steel shapes. Contractor shall follow channel strut manufacturers guidelines for loading or provide structural steel supports designed by a professional Engineer, licensed in the same state as where the project is located.

2. All piping shall be attached to the support by means of a channel strut clamp, U-bolt, or pipe rollers which will maintain lateral position of the pipe but allow longitudinal movement. Provide dielectric isolation between all dissimilar metals.
3. All insulation shall be continuous at supports. Do not notch or penetrate insulation.

I. Vertical Supports: Steel riser clamp at each floor penetration or every 14 foot supported from wall bracket. Do not anchor riser clamps.

J. Hangers:

1. General: Adjustable wrought steel clevis with locking nut attachment.
2. Multiple or Trapeze: Steel channels with welded spacers and hanger rods.
3. Hanger Sizes and Spacing:

a. For gas, domestic water and drain piping, conform to Chapter 2, Part 5, Section 121 of ASME B31.1 (Standard for Pressure and Power Piping) and applicable plumbing code.
b. For steam and hydronic piping, conform to the following table:

PIPE TYPE	PIPE SIZE	MAXIMUM SPACING	MINIMUM HANGER ROD SIZE
Steel Pipe	½"	6'-0"	3/8"
	¾" thru 1¼"	8'-0"	3/8"
	1½" and 2"	10'-0"	3/8"
	2½" thru 3½"	12'-0"	½"
	4" and 5"	15'-0"	5/8"
	6"	17'-0"	¾"
*	8" thru 12"	12'-0"	7/8"
*	14" thru 18"	10'-0"	1¼"
*	20" thru 30"	8'-0"	1½"
Copper Pipe	½" thru 1"	6'-0"	3/8"
	1¼" thru 2"	10'-0"	3/8"
	2½" thru 3"	10'-0"	½"
Cast Iron Soil	2"		3/8"
	3" to 5"		½"
	6"		5/8"
*	8" to 12"		¾"

* Submit routing and support plans to Architect/Engineer for review.

K. Insulated Pipe Supports:

1. Size pipe supports for outside diameter of pipe insulation.

L. Wall Supports:

1. 1/2" through 3": Unistrut type channel and steel clamp.

    a. Use Hydra-Zorb cushions on copper pipe.

2. 4" and Over: Welded steel bracket and wrought steel clamp.

M. Pipes over five inches and over 120º: Provide cast iron roller supports.

2.2 INSULATION INSERTS

A. All insulated pipes shall be protected at the point of support by insulation inserts. Insert to be same thickness as adjoining pipe insulation. Materials shall be suitable for use in an air plenum.

B. Provide any of the following products:

1. High density, 100 psi, waterproofed calcium silicate, encased in a sheet metal shield. Shield shall extend one inch beyond sheet metal shield. If pipe hanger spacing exceeds ten feet and for all pipe roller applications, utilize double layer shield on bearing surface.
2. Trymer Polyisocyanurate Foam insulation (urethane). Provide compressive strength and temperature range as required for pipe served. Insert shall be provided with factory applied vapor barrier.

    a. Manufacturers: Snapp Itz Mechanical Pipe Shields (BBMI, LLC) or pre-approved equal.
    b. Not for use on steam piping or other piping above 225° F.

C. Provide 180º insulation inserts when utilizing clevis hangers. Provide 360º insulation inserts at all trapeze and wall supports.

2.3 PIPE ANCHORS

A. Manufacturers:

1. Anvil
2. Cooper Industries B-Line
3. Mason
4. Metraflex

B. Design Basis – Any of the following:

1. Pipe Riser Anchor Clamp: Metraflex Riser Anchor Clamp
2. Low Load Anchor Clamp: Metraflex Model PA Anchor Clamp
3. Pre-insulated Anchor Clamp: Metraflex Model PAPI
4. Welded Structural W-Section Anchor: Metraflex Model PAI Structural I-beam Anchor

C. Material:

1. Material in contact with pipe shall be steel for steel pipe, bronze for copper tubing. Where clamp anchors are a dissimilar metal to piping, provide FRP pad secured to the pipe with epoxy adhesive to prevent metal to metal contact between clamp and pipe.

D. Anchors may be field fabricated similar to manufactured products specified.

E. Submit pipe stress analysis for review prior to installation of pipe anchors.

2.4 PIPE GUIDES

A. Manufacturers:

1. Adsco
2. Anvil
3. Cooper Industries B-Line
4. Flexicraft
5. Keflex
6. Mason
7. Metraflex
8. PHD

B. Design Basis – Any of the following:

1. Spider Type: Metraflex Style IV Spider Type guide
2. Roller Type: Two sets of rollers on opposite sides of pipe
3. Slide Type: Cooper Industries B-Line B3893 with hold down lugs (not for use with cold piping)
4. Light duty, 1-1/2” and smaller copper: U-bolt or channel strut clamp allowing clearance from O.D. of pipe or insulation
5. Pipe Riser Guides: Metraflex Modular Riser Guide

C. Material: Material in contact with pipe shall be steel for steel pipe, bronze for copper tubing. Where guides are a dissimilar metal to piping, provide FRP pad secured to the pipe with epoxy adhesive to prevent metal to metal contact between guide and pipe.

2.5 EXPANSION COMPENSATORS

A. Expansion Compensators, Two Inch and Smaller, Loop Type:

1. Manufacturers - Design Basis: Metraflex
2. Other Acceptable Manufacturers:

a. Adsco
b. Flexicraft

c. Keflex
d. Mason

3. Model: Metraloop

B. Expansion Compensators, Bellows Type:

1. Manufacturers – Design Basis: Metraflex
2. Other Acceptable Manufacturers:

a. Adsco
b. Flexicraft
c. Keflex
d. Mason

3. Model: MNLC, 300 psi max. working pressure

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE SUPPORTS

A. Adequately support piping from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging and pocketing.

1. Provide supports between piping and building structure where necessary to prevent swaying.
2. Do not support pipe from other pipe or equipment.
3. Provide thrust restraints at all changes in direction on 8” and larger cast iron piping with no hub or hub and spigot fittings.

B. Install hangers to provide minimum ½” clear space between finished covering and adjacent work.

1. Place a hanger within one foot of each horizontal elbow.
2. Space hangers generally as called for in Table in Part 2, Products.

C. Use hangers, which are vertically adjustable 1-½” minimum after piping is erected.

D. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

1. Set inserts in position in advance of concrete work.
2. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
3. Do not penetrate concrete “TT” legs for piping inserts. Do not penetrate the stressed (i.e. lower) chords of any structural member.

E. Expansion anchors or screw anchors: For use only where modifications to piping layouts to change from pre-installed insert locations and only under approval from the Engineer.

1. Installation shall be in strict compliance with ICC-ES or IAPMO-UES Research Report criteria.
2. Expansion anchors require periodic special inspection as required by their ICC-ES or IAPMO-UES Research Report.
3. Special inspector shall make periodic inspections of installation for compliance with manufacturer's installation instructions.

F. Provisions for Movement: Install hangers and supports:

1. To allow controlled movement of piping systems.
2. To permit proper movement between pipe anchors.
3. To facilitate the action of expansion joints, expansion loops, bends and offsets.
4. To isolate force due to weight or expansion from equipment connections.

G. In general, attach hangers to upper chord of roof trusses and floor joists, using long rods to facilitate pipe movement.

H. Anchors:

1. Use no pipe anchors. Arrange piping such that pipe expansion and contraction is accommodated by controlled movement of the pipe within the pipe supports. Provide sufficient offsets in branch piping to accommodate movement of main piping due to expansion and contraction.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions of the Construction Contract and Division 1 Specification Sections (General Requirements), apply to this Section.

1.2 DESCRIPTION

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.3 MATERIAL AND EQUIPMENT

A. Design Basis: Mason Industries

B. Alternate Manufacturers:

1. Amber/Booth Co.
2. California Dynamics
3. Kinetics
4. Korfund Dynamics Corp.
5. Vibration Eliminator Co.
6. Vibration Mountings & Controls, Inc.
7. Vibro-Acoustics

C. Unless otherwise specified, supply only new equipment, parts and materials.

1.4 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.

C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim or additional payment.

D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

E. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

1.5 SUBMITTALS

A. Reference Division 1.

B. Prior to ordering any products, submit shop drawings or the items listed below. The shop drawings must be complete when submitted and must be presented in a clear, easily understood form. Incomplete or unclear presentation of shop drawings may be reason for rejection of the submittal.

1. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:

    a. The equipment identification mark;
    b. A cut sheet of the isolated equipment showing equipment support points and operating weight at each point.
    c. The isolator type;
    d. The actual load;
    e. The static deflection expected under the actual load;
    f. Specified minimum static deflection;
    g. The additional deflection-to-solid under load;
    h. The ratio of spring height under load to spring diameter.

3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
4. Special details necessary to convey complete understanding of the work to be performed.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION MOUNT TYPES

A. General:

1. All metal parts of vibration isolation units installed out-of-doors shall be cold-dip galvanized, cadmium plated, or neoprene coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
2. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.
4. Static deflection of isolators shall be as provided in SECTION 3 - EXECUTION. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

B. Type FN (Floor Neoprene)

1. Neoprene isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.
2. Type FN isolators shall be Mason Type ND or approved equal.

C. Type NP (Neoprene Pad)

1. Neoprene pad isolators shall be one layer of ¼" to 3/8" thick ribbed or waffled neoprene. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type NP isolators shall be Mason Type W or approved equal.

D. Type HN (Hanger Neoprene)

1. Vibration isolation hangers shall consist of a neoprene-in-shear element contained within a steel housing. A neoprene neck bushing shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30º arc before contacting the hanger housing.
2. Type HN isolators shall be Mason Type HD or approved equal.

E. Type HSN (Hanger Spring and Neoprene)

1. Vibration isolation hangers shall consist of a free standing and laterally stable steel spring and a neoprene element in series, contained within a steel housing. Spring diameters and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30º arc before contacting the housing. Hangers shall provide a means to adjust hanger elevation under load. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Spring elements shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. The neoprene element shall be designed to have a 0.3" minimum static deflection. The deflection of both the spring element and the neoprene element shall be included in determining the overall deflection of Type HSN isolators.
2. Type HSN isolators shall be Mason Type P30N or approved equal.

2.2 FLEXIBLE DUCT CONNECTORS

A. Refer to section 23 33 00 Ductwork Accessories for flexible duct connector specifications.

B. The clear space between connected parts shall be a minimum of 3" and the connection shall have 5" minimum of slack material.

2.3 FLEXIBLE PIPE CONNECTIONS

A. Flexible pipe connection shall be fabricated of multiple plies of nylon cord, fabric, and neoprene; and shall be vulcanized so as to become inseparable and homogeneous. Flexible connections shall be formed in a double sphere shape, and shall be able to accept compressive, elongative, transverse, and angular movements.

B. The flexible connections shall be selected and specially fitted, if necessary, to suite the system temperature, pressure, and fluid type. In addition, suitable flexible connections should be selected which do not require rods or cables to control extension of the connector.

C. Connectors for pipe sizes 2" or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.

D. Flexible pipe connections shall be Mason Industries Type SFDEJ; Metraflex DoubleSphere; or Amber/Booth Type 2600 or 2655.

2.4 ACOUSTICAL SEALANT

A. Sealants for acoustical purposes as described in this specification shall be silicone or one of the non-setting sealants indicated below:

Acoustical Sealant	D.A.P
BR-96	Pecora

Acoustical Sealant	Tremco
Acoustical Sealant	U.S.G.

PART 3 - EXECUTION

3.1 APPLICATION

A. General:

1. Refer to SECTION 2 - PRODUCTS of this specification for vibration isolation devices identified on the drawings or specified herein.
2. The static deflection values of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

B. Major Equipment:

1. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as scheduled on the drawings or specified hereunder.
2. Flexible duct connectors shall be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the drawings unless noted otherwise. Individual fan units with motors rated at less than ¾ hp do not require a flexible connector.
3. Flexible pipe connections shall be installed at all pipe connections to vibration-isolated equipment in the positions shown on the drawings.

C. Pipes:

1. All condenser water piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:

    a. Within 15’ total pipe length of connected vibration-isolation equipment (pump package):

2. Piping shall be isolated from the building structure by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment or ¼” whichever is larger. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least ¼” static deflection.
4. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
5. Provide flexible pipe connections on all piping connected to all isolated equipment and wherever shown on the drawings.

3.2 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General:

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolation Mounts:

1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
2. Isolators for equipment with bases shall be located on the sides of the bases, which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called to herein.
4. Hanger rods for vibration-isolated support shall be connected to structural beams or joists, not the floor slab between beam joists. Provide suitable intermediate support members as necessary.
5. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360º about the rod axis without contacting any object.
6. Parallel running pipes may be hung together on a trapeze, which is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and non-isolated pipes on the same trapeze.
7. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
8. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
9. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Flexible Duct Connections:

1. Sheet metal ducts and plenum opening shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

D. Flexible Pipe Connections:

1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.

E. Resilient Penetration Sleeve/Seals:

1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

    a. At minimum, provide resilient penetration seals at all Mechanical, Equipment and Fan Room Penetrations.

3.3 ISOLATOR SCHEDULE

UNIT	ISOLATOR TYPE	MINIMUM STATIC DEFL.(IN.)	REMARKS
Inline Fans	HSN	2	
CRAC Unit Pump Package	HSN	2	Note 1

Notes:

1. Suspend piping segments containing air separator and expansion tank with Type HN hangers. Refer to additional piping requirements in Section 3.1 above.

END OF SECTION 23 05 48

SECTION 23 05 53 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Plastic Pipe Markers and method of application.
2. Engraved Plastic Laminate Sign.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products.

B. Where more than a single type is specified for an application, selection is Installer's option, but provide a single selection for each application.

2.2 PLASTIC PIPE MARKERS (TYPE A)

A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers, complying with ANSI A13.1.

B. For Pipes Less Than Six Inches (including insulation if any): Provide full-band pipe markers, extending 360º around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than ¾" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

C. For Pipes Six Inches and Larger (including insulation if any): Provide either full-band or strip-type markers, but not narrower than 3 x letter height, taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".

D. Lettering: Manufacturer's pre-printed wording which conforms to contract document system descriptions.

E. Match existing terminology for systems which are modified by this work.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering or as a separate unit of plastic (to accommodate both directions).

2.3 STENCILING (TYPE B)

A. Using a color contrasting to the surface to identify, spray or brush paint through neatly cut stencils.

B. Lettering shall conform to wording on contract documents. Size shall be in accordance with ANSI A13.1.

2.4 BACKGROUND COLOR AND STENCILING (TYPE C)

A. In addition to the requirements above, paint a background color band in accordance with ANSI A13.1.

2.5 VALVES TAGS

A. Brass Valve Tags: Provide manufacturer's standard 19 ga brass tag; approximately 1-1/2" round with 1/2" high, black-filled numbers and 3/16" top hole.

1. Numbers shall be sequential in accordance with schedule below.
2. Provide separate numbering for each legend sequence. Provide separate sequences for the following:

    a. Gas (GAS)
    b. Plumbing (PLBG)
    c. Heating Water (HTG)
    d. All other systems (No legend)

B. Valve Tag Fasteners: Manufacturer's standard chain (wire link or beaded type), or S-hooks.

2.6 VALVE SCHEDULE

A. Provide schedule for each piping system, as defined on the drawings, and below, typewritten and reproduced on 8-1/2" x 11" bond paper.

B. Tabulate valve number, piping system, system legend (as shown on tag), location of valve (room or space), and variations for identification (if any).

C. Provide piping schematic for each system as defined below in Part 3.

D. In addition to mounted copies, furnish extra copies for maintenance manuals as specified.

E. Valve Schedule Frames: For each page of the valve schedule, provide a glazed frame, with screws for removable mounting on masonry walls.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, 1/16” thick, black with white core (letter color).

B. Fastening:

1. Screws
2. Rivets
3. Permanent Adhesive

C. Lettering and Graphics:

1. Coordinate names, abbreviations and other designations used in the mechanical identification work, with the corresponding designations shown, specified or scheduled in the construction documents.
2. In addition, for heating or cooling units and exhaust fans, identify area served.

PART 3 - EXECUTION

3.1 GENERAL

A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, install identification after completion of covering and painting.

B. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 DUCTWORK IDENTIFICATION

A. **General:** Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow, in black or white, whichever provides most contrast with ductwork color.

B. **Location:** In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50’ spacing along exposed runs.

C. **Access Doors:** Provide stenciled or plastic laminate type signs on each duct or equipment-mounted access door in ductwork and housings, indicating the purpose of the access

(to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

3.3 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers on piping of the following systems and include arrows to show normal direction of flow.

1. Domestic water piping (hot, cold, tempered; 120º hot, 180º hot, hot water recirculating, etc.).
2. Plumbing vent and sanitary (above grade) piping.
3. Storm piping.
4. Natural gas piping, (indicate pressures).
5. Condenser water (supply and return).
6. Any other piping system as indicated on the drawings, or as required to match existing.

B. Locate pipe markers and color bands, as follows, on all piping exposed to view, above an accessible ceiling, and in accessible maintenance spaces (including chases and near access panels). In spaces exposed to view in public areas, effort is to be made to coordinate exact locations with architect.

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where there could be a question of flow pattern.
3. Near locations where pipes pass through walls, floors, or ceilings, or enter non-accessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. Spaced intermediately at maximum spacing of 50’ along each piping run.
6. Within 6’ of access doors above otherwise non-accessible ceilings and chases.

C. Type:

1. Normally exposed to view - Type A or C.
2. Normally concealed from view - Type B.

3.4 VALVE IDENTIFICATION

A. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, plumbing fixtures faucets, hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Mount framed valve schedules with piping schematics where directed by Architect.

C. Identify each valve tagged on as-built drawings.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

A. Install an engraved plastic laminate sign on or near each scheduled item of mechanical equipment.

B. Provide engraved plastic laminate nameplate on every new piece of equipment not already provided with one in accordance with Section 23 05 02 of the specifications.

C. Identify area served, if applicable.

3.6 NON-POTABLE WATER IDENTIFICATION

A. Provide an engraved plastic laminate sign.

1. Legend: “Non-Potable Water”.
2. Location: At each outlet of piping downstream of backflow preventer, (e.g. Boiler Room hose bibb).

END OF SECTION 23 05 53

SECTION 23 05 93 - TEST-ADJUST-BALANCE

PART 1 - GENERAL

1.1 RESPONSIBILITY

A. The Balancing Contractor shall be a sub-contractor, directly working for the General Contractor.

B. The Balancing Contractor shall not be a sub-contractor of any other Division 21, 22 or 23 Contractor.

1.2 QUALITY ASSURANCE

A. Qualification:

1. Work shall be done by a firm certified by the National Environmental Balancing Bureau (NEBB), or the Associated Air Balance Council (AABC), or the firm shall have technicians certified by the “National Training Fund Sheet Metal & Air Conditioning Industry”.
2. The firm shall be an independent testing and balancing form specializing in testing and balancing of environmental systems.
3. The firm shall have an experience record of not less than five (5) years of experience in the TAB industry.

B. Industry Standards: Comply with the following:

1. HVAC Systems-Testing, Adjusting, Balancing published by Sheetmetal and Air Conditioning Contractors National Association, Inc. (SMACNA).
2. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems published by National Environmental Balancing Bureau. (NEBB).
3. ASHRAE Systems Handbook. Testing, Adjusting and Balancing.

C. Registration: Work shall be done under the supervision of a professional engineer registered in Colorado. Engineer shall be available for all meetings and interpretation of all materials in the report.

D. Pre-qualification of TAB Contractor.

1. The firm must have experience and qualifications satisfactory to the consulting mechanical engineer and must be accepted by them prior to bidding.
2. Firms desiring approval to provide work under this section shall submit a booklet indicating procedures and data forms that they would use in the performance of the work.
3. Submittals shall be in accordance with Division 1.

4. Only firms which have been approved by the mechanical engineer prior to bid date may provide work under this section.

PART 2 - PRODUCTS

2.1 PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

A. Sequence work to commence after completion of system and start-up procedures and schedule completion of work before Substantial Completion of Project.

B. Examine the installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable.

C. Notify the Contractor in writing of conditions detrimental to the proper completion of the test-adjust-balance work.

1. Do not proceed with the work until unsatisfactory conditions have been corrected.
2. Provide Engineer/Architect with a copy of the notification.

D. Adjust air flows and heating water systems to within 10% of values shown. Adjust chilled water systems to within 5% of values shown. If design flows cannot be obtained within specified limits the Balancing Contractor will perform the following (at the minimum):

1. Measure and record major pressure drops in the system.
2. Consult with the Engineer and Installer as required.
3. Upon receiving written directions to proceed and after any corrections are performed, re-balance affected portion of system.

E. Optimization: Work closely with the Section 23 09 00 contractor to optimize setpoints.

1. Establish the minimum air static pressure or water differential pressure for variable or bypass flow system.
2. Establish the position of minimum outside air dampers, damper/valve and sequencing relays.

F. Calibration: Be responsible for calibration of flow measurement devices used as input to the temperature control system. All air systems flow measurement stations including VAV terminals shall be calibrated against a pitot tube traverse or air diffuser capture hood. Balancing contractor shall assure accuracy of all flow measurement devices or shall report on their failure to be accurate.

G. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in a manner recommended by the original Installer.

H. Make all final readings for each system at the same time, and after all adjustments have been made.

I. Mark equipment settings, including damper control positions, balancing cocks, circuit setters, valve indicators, fan speed control settings and similar controls and devices, to show final settings at completion of test-adjust-balance work.

1. Mark with paint or other suitable permanent identification material.

J. Check all new thermal overloads.

1. Identify improperly protected equipment in report.

3.2 AIR SYSTEMS

A. Scope: All air systems are to be balanced.

B. Before any adjustments are made, check for:

1. Dirty filters, coils, or air intakes
2. Duct leakage
3. Filter leakage
4. Damper leakage, or blockage
5. Equipment vibrations
6. Correct damper operation

C. Simulate a pressure drop across filters equal to that when 50% loaded with dust.

1. Check fan motor amps with clean filters and simulated loaded filters, and report.

D. Procedure:

1. Measure and report the following for all supply, return, exhaust, and outside air systems:

    a. Individual air inlets and outlets.
    b. Pitot traverses of main supply, return, exhaust and outside air ducts.
    c. Rotating valve or velocity grid traverse of coils or filters.
    d. Plot operating point on fan curve. Include compensation for effects of altitude and inlet vanes.

2. Above measurements shall be made with system in normal, full load condition.
3. Set fan speed such that under no condition will the motor exceed the service factor rating when operating in any of the above possible modes.
4. Measure fan motor amps in each of the above possible operating modes (clean filters).

E. Adjust Air Systems to provided proper air pressure relationships as shown by relative air quantities or as indicated on the drawings.

F. Adjust distribution system for uniform space temperatures.

G. Exchange sheaves and belts as required to adjust the rpm of all fans so they handle specified air quantity.

3.3 DETAILED REQUIREMENTS

A. Measure, adjust and report the following:

1. Computer Room Air Conditioning Units

    a. Total supply air CFM, fan speed, inlet pressure, outlet pressure, amp draw.
    b. Filter pressure drop.
    c. Coil airflow.
    d. Coil entering and leaving air temperature.
    e. Condenser water flow rate
    f. 3-way valve operation
    g. Refrigerant suction pressure.
    h. Compressor amps and kW draw.
    i. Automatic re-start upon loss and regain of electrical power.
    j. Space temperature at thermostat or sensors.

2. Pump Package:

    a. Automatic change-over and run-time equalization
    b. Entering water pressure
    c. Leaving water pressure
    d. Pump amps and kW draw

3. Dry Coolers:

    a. Ambient outside air temperature at condensing section.
    b. Condenser fan amps and kW draw.

4. Ductwork Systems:

    a. Airflow at each inlet and outlet.
    b. Airflow at supply, return, outside air, and exhaust mains to determine total airflow.

5. Ventilation/Outside Air Fans:

    a. Total fan CFM.
    b. Fan speed.
    c. Fan total static pressure.

6. Cabinet Heaters and Unit Heaters:

    a. Entering and leaving air temperature.
    b. kW draw on electric coils.
    c. Room air temperature.

3.4 REPORT

A. Provide a general information sheet listing:

1. Instruments used:

    a. Most recent calibration date.

2. Method of balancing.
3. Altitude correction.
4. Manufacturer’s performance data for all air devices used.

B. Provide data sheets for all equipment, including motors and drives, listing:

1. Make
2. Size
3. Serial number
4. Capacity Rating
5. Amperage
6. Voltage input
7. Thermal heater size for each motor
8. Operating speed of driver and driven devices
9. Any additional pertinent performance data

C. Include design and final values for all items listed in Detailed Requirements, and totals for each system.

D. Provide data sheets showing:

1. Air flow at each inlet and outlet
2. Instrument used
3. Velocity reading
4. Manufacturer’s free area factors

E. Provide recap sheet with explanation for each device not meeting specified performance.

F. Provide a set of prints with equipment, inlets and outlets marked to correspond to data sheets.

3.5 COMMISSIONING

A. Reference Section 23 08 00 for commissioning scope.

B. Provide all necessary personnel, tools and equipment to comply with the commissioning scope.

END OF SECTION 23 05 93

SECTION 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data on the following:

1. Insulation.
2. Jackets, coatings and protective finishes.
3. Sealers, mastics and adhesives.
4. Fitting covers.
5. Manufacturer's installation details for fire rated duct wrap.
6. Low-Emitting Adhesives and Sealants EQc4.1 requirements for LEED submittals.

1.2 FLAME AND SMOKE RATINGS

A. Provide insulation tested on a composite basis (insulation, jacket, covering, sealer, mastic and adhesive) complying with the following:

1. Flame Spread: 25 or Less
2. Smoke Developed: 50 or Less
3. Method: ASTM E84 (NFPA 255)

1.3 PRODUCT DELIVERY

A. Deliver insulation products in factory containers bearing manufacturer's label showing fire hazard rating, density and thickness.

1.4 DEFINITIONS

A. Exposed Location: Located in mechanical rooms or other areas exposed to view.

B. Concealed Location: Located in pipe chases, furred spaces, attics, crawl-spaces, above suspended ceilings, or other locations not exposed to view.

1.5 STANDARDS

A. Comply with the latest edition of National Commercial and Industrial Insulation Standards.

B. Comply with the latest edition of the California Energy Commission Title 24 requirements.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Manufacturers:

1. 3M
2. Aeroflex
3. Armacell
4. ITW
5. Johns-Manville
6. K-Flex
7. Knauf
8. Manson Insulation
9. Owens-Corning
10. Unifrax

B. Materials:

1. **Type FP** - Fiberglass Pipe Insulation: Johns-Manville Micro-Lok heavy density pipe insulation with AP-T jacket.
2. **Type FPF** - Fiberglass Pipe Fitting Insulation: Johns-Manville "Zeston" fitting covers with factory-cut fiberglass insulation insert.
3. **Type FCCP** - Flexible Closed Cell Pipe Insulation: Armacell AP Armaflex, Aeroflex Aerocel, or K-Flex Insul-Tube. Compliant with ASTM E 84, NFPA 90A, and NFPA 90B.
4. **Type FCCP**-O – UV Resistant Flexible Closed Cell Pipe Insulation: Armacell UT Solaflex, Aerocel AC, K-Flex Insul-Tube with AL Clad System.
5. **Type CGP** - Cellular glass with vapor barrier coating: Owens Corning FOAMGLAS.
6. **Type RCCP** - Rigid Closed Cell Insulation (not for use indoors): ITW Trymer 2000XP, Dyplast ISO-C1/2.0, or GLT Products ISO-C1.
7. **Type PFW** - Plenum Fire Wrap: 3M Fire Barrier Plenum Wrap 5A+ or Unifrax FyreWrap 0.5 Plenum Insulation.

Materials indicated are provided as design basis. Equivalent insulation product by manufacturer indicated above is acceptable.

C. Insulation thickness and conductivity: (Thickness and conductivity listed below are minimum required. Provide thickness and conductivity required by Local Building or Energy Codes).

1. Condenser Water:

a. All temperatures: (Insulation conductivity: 0.21–0.27 (Btu x in.)/(h x ft^2 x ^oF))

1) Sizes smaller than 1-½": ½"
2) Sizes 1-½" and larger: 1"

2. Refrigerant Suction Lines:

    a. 40ºF to 60ºF: (Insulation conductivity: 0.21–0.27 (Btu x in.)/(h x ft^2 x ºF))

        1) Sizes smaller than 1-½": ½"
        2) Sizes 1-½" and larger: 1"

    b. 40ºF and under: (Insulation conductivity: 0.20–0.26 (Btu x in.)/(h x ft^2 x ºF))

        1) Sizes smaller than 1": ½"
        2) Sizes 1" and larger but smaller than 8": 1"
        3) Sizes 8" and larger: 1-½"

3. Refrigerant Liquid Lines:

    a. All Sizes: ½" (1" for fiberglass)

4. Refrigerant Hot Gas Lines:

    a. Sizes smaller than 1-½": ½"
    b. Sizes 1-½" and larger: 1"

5. Repairs to Existing Insulation: Match thickness of existing insulation.
6. All Heat Traced Piping: (Insulation conductivity: 0.27 or less (Btu x in.)/(h x ft^2 x ºF))

    a. Refer to specification section 230503 Basic Mechanical Materials and Methods for insulation thickness.

7. Condensate Drain Piping:

    a. All sizes: ½" (1" for fiberglass)

8. PVC pipe in plenums or above noise sensitive areas:

    a. All sizes: See Part D.

D. Application: Unless otherwise indicated, use the following:

1. Inside, above ground: **Type FP** fiberglass.
2. Inside exposed: **Type FP** fiberglass with PVC jacket (jacket not required in mechanical rooms).
3. Outside building envelope:

    a. Insulation thickness 1-1/2" and larger **or** line size 2-1/2" and larger: **Type RCCP** rigid closed cell with aluminum jacket.

        1) Provide sealant at all point joints to maintain vapor barrier.
        2) Sealant shall be per insulation manufacturer recommendation.

3) Sealant submittal shall include a letter from the insulation manufacturer verifying that proposed sealant is compatible with insulation.

b. Insulation thickness less than 1-1/2" **and** line size less than 2-1/2": **Type FCCP-O** UV resistant flexible closed cell with aluminum jacket or flexible PVC insulation protector, Airex E-Flex or approved equal.

4. Below grade or slab:

a. Pipe size 1½" and less: Single piece of **Type FCCP** flexible closed cell insulation slipped over soft annealed copper tube without slitting insulation.
b. Pipe size 2" and larger: **Type RCCP** rigid closed cell insulation with shrink fit jacket or Pre-insulated/Buried Pipe per section 23 21 13 Hydronic Piping.

5. PVC piping in return air plenum: **Type PFW** plenum fire wrap to meet ASTM E84 (NFPA 255) flame spread and smoke developed ratings. Thickness to be provided in accordance with manufacturer's literature
6. Refrigerant piping, inside, above ground: **Type FCCP** flexible closed cell insulation.
7. Refrigerant piping, outside building envelope: **Type FCCP-O** UV resistant flexible closed cell insulation.
8. Condensate drain piping: **Type FCCP** flexible closed cell or **Type FP** fiberglass insulation.

2.2 DUCT INSULATION

A. Manufacturers:

1. Aeroflex
2. Armacell
3. Certainteed
4. Johns Manville
5. K-Flex
6. Knauf
7. Owens-Corning

B. Materials:

1. **Type FDL** – Fiberglass Duct Liner: See Section 23 31 13, for duct liner requirements.
2. **Type FCCL** – Flexible Closed Cell Duct Liner: See Section 23 31 13, for duct liner requirements.
3. **Type FDW** - Flexible Faced Fiberglass Ductwork Insulation Wrap: Johns-Manville Microlite, with FSK factory applied foil-scrim-kraft facing. ASTM E 84 compliant.
4. **Type RDB** - Rigid Fiberglass Ductwork Insulation: Johns-Manville 800 Series, Spin-Glas Type 814, 3 lb. Density rigid board with FSK jacket.
5. **Type RDB-O** - Rigid Glass Mineral Wool Ductwork Insulation: Knauf Earthwool with all service jacket (ASJ).

6. **Type FD** - Flexible Plain Fiberglass Ductwork Insulation: Johns-Manville Microlite .75 lb/cu. Ft. unfaced.
7. **Type FCCD** - Flexible Closed Cell Duct Insulation: Armacell AP Armaflex, Aeroflex Aerocel, or K-Flex Insul-Sheet. ASTM E 84 compliant. Where located outside the building envelope, provide UV resistant paint.
8. **Type CGD** - Cellular Glass Ductwork Insulation: Owens Corning FOAMGLAS with vapor barrier.
9. **Type ALJ** - Outdoor Aluminum Jacket: 3M Venturclad 1579 GCW-WME with white finish, Polyguard Alumaguard Cool Wrap with white finish, or MFM Flex Clad 400 with white finish.
10. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles, and similar accessories as recommended by the insulation manufacturer for the applications indicated.

Materials indicated are provided as design basis. Equivalent insulation or jacketing product by manufacturer indicated above is acceptable.

C. Application:

SYSTEM	EXPOSED	CONCEALED	OUTDOOR
Supply	N/A	N/A	N/A
Return	N/A	N/A	N/A
Exhaust	N/A	N/A	N/A
Outside Air (Note 3)	1" **Type RDB** external rigid for rectangular ductwork and 1 ½" **Type FDW** duct wrap for round ductwork	1 ½" **Type FDW** duct wrap	N/A

1. Reference 23 07 00/ Duct Insulation.
2. Insulate all accessories and components (fire dampers, silencers, air valves, etc.) of the duct systems noted above as requiring insulation.
3. All ductwork downstream of supply fan to the areas served shall be considered outside air ductwork and shall be insulated with external rigid board for rectangular ductwork or external wrap for round ductwork. All ductwork upstream of supply fan shall be uninsulated.

2.3 EQUIPMENT INSULATION

A. Manufacturers:

1. Aeroflex
2. Armacell
3. Certainteed
4. Johns Manville
5. K-Flex
6. Knauf
7. Manson Insulation
8. Owens-Corning

B. Materials:

1. **Type FE** – Fiberglass Pipe and Tank Insulation: Johns-Manville Micro-Flex Large-diameter Pipe and Tank Fiberglass Insulation. Insulation shall be designed to conform to curved surfaces while maintaining insulation thickness and high compressive strength.
2. **Type FCCE** - Flexible Closed Cell Insulation: Armacell AP Armaflex, Aeroflex Aerocel, or K-Flex Insul-Sheet, sheet form. ASTM E 84 compliant.
3. Jacketing Material: PVC roll jacketing. Seal all joints.
4. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, metal covers, adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. Application:

1. Thickness: Refer to Part 3.
2. Inside, above ground: **Type FE** pipe and tank insulation.
3. Inside, exposed: **Type FE** pipe and tank insulation with PVC jacket (jacket not required in mechanical rooms).
4. Outside building envelope: **Type FCCE** flexible closed cell with UV resistant painted finish, white in color unless otherwise noted. Paint shall be by same manufacturer as insulation.

    a. Provide sealant at all point joints to maintain vapor barrier.
    b. Sealant shall be per insulation manufacturer recommendation.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify acceptability of all materials which are to be used in air plenums (above ceiling, etc.). Materials must meet all requirements of Local Building Code and Authority having jurisdiction.

3.2 PIPE INSULATION

A. Insulate the following:

1. Domestic cold water piping above ground and under slab.
2. Condenser water piping.
3. Refrigerant hot gas, liquid, and suction lines.
4. All existing piping which is currently insulated and which is modified as a result of this work.
5. Condensate drain piping.
6. Heat traced piping.
7. All PVC piping located in return air plenums.

B. Installation:

1. Install insulation on pipe system subsequent to testing and acceptance of tests.
2. Install insulation materials with smooth and even surfaces.
    a. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete the run.
    b. Do not use cut pieces or scraps abutting each other.
3. Clean and dry pipe surfaces prior to insulating.
    a. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
4. Extend piping insulation without interruption through pipe clamps, hangers, walls, floors and similar piping penetrations, except where otherwise indicated. **Hangers and supports must be installed outside, not through, insulation.**
5. Install protective metal shields and saddles where needed to prevent compression of insulation. Refer to Section 23 05 29.
6. Except as noted, cover valves, flanges, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run.
    a. Install factory-molded, pre-cut or job-fabricated units (at Installer's option), except where a specific form or type is indicated.
    b. Do not cover:
        1) Valve operators.
    c. Provide removable access for:
        1) Strainers.
        2) Other components requiring access for service.

7. Mark location of unions and flanges covered by insulation with permanent paint or ink, or approved label.
8. Maintain integrity of vapor-barrier jackets on insulation of cold pipes and storm drainage piping, and protect to prevent puncture or other damage.
9. Insulate between pipe and pipe saddles. Provide suitable saddles.
10. Seal ends of sections with vapor barrier cement to crate moisture dams at:

    a. 21 ft. intervals.
    b. Valves and fittings.
    c. All hangers and supports.

11. On underground pipe insulation, install unicellular insulation on pipe without slitting insulation.

    a. Seal all transverse joints with adhesive.

12. Replace existing insulation removed or damaged because of work of this project.
13. Insulate new pipes and replace insulation on existing pipes to remain where insulation was removed or damaged by demolition or revisions.
14. Do not insulate basket access flange of flanged strainers.
15. Insulate between fingers of spiders in alignment guides.
16. Insulate between pipe and pipe slide.
17. Perform all work in a neat and workmanlike manner. Poor work (as determined by Architect or Engineer) will be cause for rejection.

3.3 UNDERGROUND HYDRONIC PIPE INSTALLATION

A. Portions of the condenser water piping system shall be insulated below grade.

B. The installed piping system shall have the following characteristics.

C. Insulating Value: The system shall provide a conductivity of 0.165 Btu-in/hr ft^2 F^o at 75^{o}F (r-value of 6).

1. The insulation shall be Foamglass Pittwrap SS II, waterproof (not lose insulating value when saturated with liquid water or completely sealed against the introduction of water) and 2” thick.
2. The exterior of the pipe shall be completely sealed against the introduction of moisture when the system has been installed in ground water saturated fill.
3. The system shall be compatible with the excavation and backfilling methods and materials used.
4. The system shall be able to sustain medium duty tract loading (1000 lb wheel loading at the surface) without damage.

D. Minimum burial depth shall be 5’-0” below finished grade.

E. The actual system used shall be at contractor's option as long as the above criteria is met, and may be a pre-fabricated or field built system. However, if the system submitted by the Contractor does not meet the criteria (as determined by Engineer), the Contractor shall supply a double pipe pre-fabricated system equivalent to that manufactured by Ricwil or Perma-Pipe.

3.4 OUTDOOR PIPE INSULATION

A. Install rigid insulation with butt joints of half pipe sections staggered. Insulation shall be held in place with strapping tape.

B. Install aluminum jacket with all joints lapped to shed water. Apply a bead of silicone sealant at all transverse and longitudinal seams. Secure with aluminum bands, minimum of 2 per jacket section. Contractor to verify that sealant has been applied per sealant and insulation manufacturer recommendations for proper vapor barrier.

C. Install flexible PVC insulation protector per manufacturer's installation requirements. Contractor to verify that insulation protector has been applied per insulation protector and insulation manufacturer recommendations for proper vapor barrier.

3.5 DUCTWORK INSULATION

A. Install insulation materials with smooth and even surfaces.

B. Clean and dry ductwork prior to insulating.

1. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

C. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated. **Hangers and supports must be installed outside, not through, insulation.**

D. Except as otherwise indicated, do not insulate lined ducts. However, extend duct insulation 12" beyond start of lining where lined ductwork meets insulated ductwork.

E. Maintain integrity of vapor-barrier on insulation of ducts carrying cold air, and protect it to prevent puncture and other damage.

F. For Outdoor Insulation:

1. Stagger joints on multilayer applications.
2. Locate joints at sides of ducts whenever possible.
3. Utilize adhesive and vapor retarder as indicated by manufacturer for outdoor applications.
4. Use full coverage adhesive to adhere external insulation to ductwork. For flexible closed cell insulation, adhesive shall be by insulation manufacturer.
5. Vapor retarders shall overlap a minimum of 2" at all seams.

6. Cover flexible connections.
7. Extend covering to inside face of wall/roof.
8. Provide all exposed rigid insulation surfaces with protective aluminum jacket. Provide backing and aluminum jacketing tape at all sharp edges and fasteners. Do not puncture aluminum jacket.
9. Provide all outdoor flexible closed cell insulation with UV resistant painted finish, white in color unless otherwise noted. Paint shall be by same manufacturer as insulation.

3.6 EQUIPMENT INSULATION

A. Install insulation materials with smooth and even surfaces and on clean and dry surfaces.

1. Re-do poorly fitted joints.
2. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

B. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

C. Apply insulation using the staggered joint method for both single and double layer construction, where feasible.

1. Apply each layer of insulation separately.

D. Do not insulate handholes, cleanouts, ASME stamp and manufacturer’s nameplate.

1. Provide neatly beveled edge at interruptions of insulation.

E. Cold Equipment (At or below ambient equipment):

1. Includes domestic cold water and condenser water system equipment such as air separators, expansion tanks, etc.
2. Insulate air separators with 2 inches of equipment insulation or 1½ inches of cellular glass insulation.

3.7 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily. Including units with vapor barrier damage and moisture saturation.

B. Protection: The insulation installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period, to avoid damage and deterioration.

3.8 ASBESTOS REMOVAL

A. It is understood and agreed that this work does not contemplate handling of, or design including use of, asbestos or any hazardous waste material. Therefore, Owner and Contractor agree to hold harmless, defend and indemnify consultant (A/E) for all claims, lawsuits, expenses or damages arising from or related to the handling, use, treatment, purchase, sale, storage or disposal of asbestos, asbestos products or any hazardous waste materials.

B. In the event asbestos is encountered the Contractor shall immediately cease work in the area of the asbestos shall contact the Engineer and Owner for instructions.

C. Regulations:

1. Follow Section 1910.1001 Code of Federal Regulations Title 29, Part 1910 (OSHA Asbestos Regulations).
2. Provide daily sampling during removal instead of at six month intervals.
3. Stop work and notify Architect immediately if levels exceed those of Subparagraphs b (2) or b (3) of regulations.
4. Dispose of material containing asbestos using methods approved by EPA at sites approved by EPA.

END OF SECTION 23 07 00

SECTION 23 08 00 - BUILDING MECHANICAL SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplemental Conditions and Section 23 05 02 apply to all work specified in this section.

B. Refer to Specification Section 23 05 93, title “Test and Balance” for interface requirements with test and balance contractor.

1.2 DESCRIPTION OF WORK

A. This specification covers the start-up, operating performance test and commissioning of the HVAC systems. The purpose of this effort is to bring the project mechanical systems to a state of dynamic operation in accordance with the contract documents by verifying the operation of individual components, subsystems and systems.

B. The Owner will retain the services of an independent commissioning agent (CxA) separate from the work of this Contract. As herein specified the Owner and CxA shall develop detailed commissioning procedures, equipment checkout procedures and data forms for recording compliance with contract documents, performance and punchlist deficiencies, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

C. The Division 23 Mechanical Contractor and the General Contractor shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to accomplish the work and labor and material for execution, monitoring and printing data forms necessary to verify and record system observations.

D. The Test and Balance Contractors shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to execute and accomplish the work.

E. At the completion of the start-up, operations performance test and test and balance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems in the presence of the Owner/Architect/Engineer and CxA.

1.3 COMMISSIONED EQUIPMENT

A. All CRAC units, pump packages, dry coolers as scheduled.

B. All ventilation fans and duct heaters as scheduled.

C. All miscellaneous heating as scheduled.

1.4 COMMISSIONED SYSTEMS

A. CRAC unit control system.

PART 2 - PRODUCTS

2.1 MATERIALS, LABOR, INSTRUMENTS, TOOLS, LADDERS AND APPARATUS

A. The Contractor shall provide all materials, labor, instruments, tools, ladders and apparatus necessary to start-up, perform operating performance test and systems conditioning.

B. The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. Final checklists will be produced by the CxA and provided prior to beginning commissioning. The commissioning documentation shall be kept current by the Contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Contractor shall surrender 3 completed copies of the commissioning documentation to the Owner's representative.

PART 3 - EXECUTION

3.1 START-UP AND OPERATING PERFORMANCE TEST

A. Before request for contract compliance inspection and system commissioning all equipment, components, and systems shall be started-up, adjusted, calibrated; set, test and check all electric disconnect, fuses, circuit breakers, valves, dampers, temperatures and pressures of all systems for proper operation and performance. After completion of the start-up and operating performance test, the Contractor will notify the Owner in writing that the system is ready for commissioning.

B. Information, date, etc. from start-up and operating performance test may be utilized, as appropriate, to execute preliminary commissioning documentation, however, certification of equipment and systems for the preliminary commissioning phase shall be completed in accordance with paragraph 3.2 of this section of the specifications.

C. Start-up and operating performance test documentation shall include the following:

1. Computer Room Air Conditioning Units

    a. Total supply air CFM, fan speed, inlet pressure, outlet pressure, amp draw.
    b. Filter pressure drop.
    c. Coil airflow.
    d. Coil entering and leaving air temperature.
    e. Condenser water flow rate
    f. 3-way valve operation
    g. Refrigerant suction pressure.
    h. Compressor amps and kW draw.
    i. Automatic re-start upon loss and regain of electrical power.
    j. Space temperature at thermostat or sensors.

2. Pump Package:

    a. Automatic change-over and run-time equalization
    b. Entering water pressure
    c. Leaving water pressure
    d. Pump amps and kW draw

3. Dry Coolers:

    a. Ambient outside air temperature at condensing section.
    b. Condenser fan amps and kW draw.

4. Ductwork Systems:

    a. Airflow at each inlet and outlet.
    b. Airflow at supply, return, outside air, and exhaust mains to determine total airflow.

5. Ventilation/Outside Air Fans:

    a. Total fan CFM.
    b. Fan speed.
    c. Fan total static pressure.

6. Cabinet Heaters and Unit Heaters:

    a. Entering and leaving air temperature.
    b. kW draw on electric coils.
    c. Room air temperature.

3.2 SYSTEM COMMISSIONING

A. All systems, components, equipment, etc. furnished as part of this Contract shall be subjected to system commissioning as hereinafter specified. All systems, components, equipment, etc. commissioned in this section of the Specifications shall be evaluated based on the sequences of control/operation, performance characteristics, and equipment schedules, etc. as specified in other sections of the Specifications and as shown on the contract drawings. Systems, components, equipment, etc. that does not have specified operating sequence, etc. shall be operated and evaluated based on its use and function for this project.

B. Commissioning Documentation: The Contractor shall maintain the commissioning documentation in 3-ring binders. The commissioning documentation shall be organized by system when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:

1. Design Criteria provided by the A/E.
2. Approved Test and Balance Report for the system or component being commissioned, provided by Test and Balance Contractor.
3. Approved submittals for all equipment to be commissioned, provided by Mechanical Contractor.
4. All approved shop drawings of equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders. Provided by Mechanical Contractor.
5. All pre-commissioning checklists initialized by indicated personnel organized by system and subsystem.
6. All functional performance test checklist initialized by indicated personnel organized by systems and subsystems.
7. Three copies of the Operation and Maintenance Manuals specified in other sections of these specifications shall be reviewed by the CxA for completeness and for applicability. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.

C. Shop Drawings and As-Built Drawings and Specifications shall be assembled by the Contractor after completion of the pre-commissioning phase and turned over to the Owner's representative. Changes as a result of subsequent Commissioning procedures will be incorporated (as required) at the conclusion of final Commissioning.

D. Commissioning Schedule:

1. Phase 1 - Preliminary Commissioning: All shop drawings, including but not limited to, equipment, controls, test and balance reports, and operation and maintenance manuals, shall be submitted and approved by the CxA. In addition, all pre-commissioning checklists shall be completed (initialed by all parties).
2. Phase 2 - Functional Performance Testing shall be performed as indicated on the Functional Performance Test Checklists. Functional Performance Testing shall not begin until Phase 1 of the commissioning process is complete. Owner's operation and

maintenance personnel shall observe the function performance testing. The Contractor may perform initial system familiarization and training of Owner's operating and maintenance personnel required under other sections of the Specification during the functional performance testing.

3. Functional Performance Test Notification: The Contractor shall notify the CxA 2 weeks before functional performance testing is to begin.
4. Phase 3 - System training and operating instructions shall be conducted by the Contractor as indicated in the specifications of each item of equipment. The Contractor shall be responsible for specified training and operating instructions being observed by the CA.

E. Pre-Commissioning Checklists:

1. Pre-Commissioning Checklists shall be developed by the CxA and shall be executed and certified prior to the commencement of functional performance testing. The indicated initial is required in each location for all items, except where an "X" is shown indicating an initial is not required. See initials legend below for required initials. The pre-commissioning checklist will not be accepted as complete until all items have been initialed signifying this portion of the project is ready for Functional Performance Testing. The Contractor shall provide the CxA with the completed Pre-Commissioning Checklists for their review and initials. The CxA shall be the last person to initial each checklist item. The Contractor shall submit for approval a list of all contractor and subcontractor representatives responsible for the completion of the pre-commissioning checklist phase of the project. This list of representatives shall be submitted 2 weeks prior to commencement of any pre-commissioning activities of any systems or equipment. Representatives may be replaced only after written approval from the CxA.
2. Initials Legend:

    a. Construction Manager.
    b. Mechanical Contractor's representative.
    c. Electrical Contractor's representative.
    d. Commissioning Agent.
    e. Balancing Contractor's representative.
    f. Controls Contractor's representative.

3. Blank Example Pre-Commissioning Checklists are in Appendix, located at the end of this section of the specifications. A separate Pre-Commissioning checklist shall be provided for each system and piece of HVAC equipment to be Commissioned.

F. Functional Performance Test Checklist:

1. Functional performance testing shall be performed by the Contractor as directed by the CA and observed by a commissioning team consisting of the individuals indicated on the Functional Performance Test Checklists. The Contractor shall submit in writing a list of all contractor and subcontractor representatives responsible for the functional performance testing phase of the project. This list of representatives shall be submitted 2 weeks prior to the commencement of functional performance testing of systems and equipment. All representatives shall remain on the commissioning team throughout

functional performance testing. Substitutions will not be permitted. Functional performance test checklists shall be completed in the presence of all commissioning team personnel at the time of the functional performance test.

2. Upon failure of completion of a functional performance test checklist, the Contractor shall provide a written report to the CxA listing the deficiencies causing the failure and remedies to correct all deficiencies. After the Contractor has corrected all deficiencies, the entire functional performance test checklist for the item of equipment shall be repeated. If possible, corrections can be accomplished during the functional performance testing of equipment in other non-related systems. In any case, no system will be accepted until all equipment items in the system have complete functional performance test checklists thereby demonstrating satisfactory performance.
3. Failure to complete 2 functional performance test checklists constitutes failure of Phase 2 of the HVAC Commissioning process. The Contractor shall provide a written report to the CxA listing the deficiencies causing all failures and remedies to correct all deficiencies. After correction of all deficiencies, Phase 2 of the HVAC Commissioning process shall be repeated in its entirety. The Contractor shall give the CxA 2 weeks notice before repeat functional performance testing is scheduled. Should the first or one subsequent functional performance test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to perform more than two (2) functional performance tests.
4. Blank examples functional performance test checklists are in the Appendix 2 located at the end of this section of the specifications. A separate Functional Performance Checklist shall be provided for each system and piece of equipment to be Commissioned.

3.3 DEMONSTRATION TEST

A. After completion of system start-up, operating performance test and commissioning, but before Owner acceptance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems provided under this Contract. The intent of the 72 hour dynamic test is to verify that the mechanical and electrical equipment will respond as designed to meet the changes that may occur under varying indoor/outdoor conditions including seasonal variations and occupancy loads.

B. A detailed procedure and sequence of events shall be developed by the Contractor and submitted to the Owner and CxA for review and approval. Procedures and sequence of events should contain as a minimum the following activities:

1. Hours 1-4: Bring all systems online for standard operations and parameters.
2. Hours 5-28: Operate all systems under normal parameters and verify proper operation.
3. Hours 29-52: Validation of systems operation through indoor/outdoor changes to include heating, cooling, ventilation, humidity control, domestic and control systems.
4. Hours 69-72: Return of systems to normal operation.

C. Systems and their associated equipment which are to be included in the dynamic test are all systems and components furnished under this Contract and as a minimum will include, but are not limited to the following:

1. CRAC units
2. Ventilation fan and duct heater

D. Contractor shall notify the Owner and CxA in writing that the project is completed and ready for the demonstration test. Schedule for test will then be established and documented. Initiation of the 72 hours dynamic test will not occur until all systems are balanced, operational and incorporated into the building management and control system. Should the demonstration test fail for any reason, the problems shall be corrected and another demonstration test conducted. Should the first or one subsequent demonstration test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to witness more than two (2) 72 hour demonstration tests.

E. The attendees of each 72 hour demonstration test shall include representative from the following organizations:

1. General Contractor
2. Mechanical Contractor
3. Electrical Contractor
4. Test and Balance Contractor
5. Building Management and Control System Contractor
6. Architect of Record
7. Mechanical Engineer
8. Electrical Engineer
9. Commissioning Agent

Minor problems are anticipated and the necessary personnel required to correct problems and adjust systems need to be available to insure continuation of the dynamic testing process. If major problems are encountered, at the discretion of the Owner and CxA, the testing will be terminated and rescheduled.

The Contractor shall notify any external organizations, which would include but not be limited to the Owner and Fire Department which are not directly involved in the testing, but might be affected due to interface to insure that alarms do not occur.

F. During the demonstration test all systems shall operate in the “hands-off” automatic mode in accordance with the requirements of the Contract Documents. Changes in operating modes required to simulate load shifting, seasonal changeover, emergency modes, etc. will be accomplished by changing set points and equipment operating status at the BMS central control console as required to observe capacity control and monitoring. Provide a readout of space

temperature at each thermostat building relative humidity, building pressurization, chilled water supply and return temperatures and chiller capacity.

END OF SECTION 23 08 00

SECTION 23 08 01 - COMMISSIONING AGENT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to section 23 08 00 for commissioning requirements and Division 1 for additional information.

1.2 DESCRIPTION OF THE WORK

A. This Section covers the Scope of Work for the Commissioning Agent (CxA) who will be hired by the Owner.

B. The Commissioning Agent shall oversee the commissioning of the HVAC systems as described in Section 23 08 00. The CxA shall prepare precommissioning and functional performance test checklists to be used by the Contractor. Prepare and publish a commissioning plan. Witness startup and operational tests of equipment and systems. Perform observations of the mechanical systems throughout construction and prepare the final commissioning document.

C. The CxA shall have authority to direct and schedule test. The CxA shall have no authority to direct changes to the systems, or provide design related review comments.

1.3 COMMISSIONING PLAN

A. The CxA shall prepare a plan listing the parties involved with their responsibility, scope, definitions, safety concerns, design criteria, attendance schedules, commissioning schedules, and commissioning manual requirements.

1.4 COMMISSIONING FORMS

A. Review 100% CD’s. Provide written summary of how each commissioned item of equipment, should operate include calculations verifying scheduled capacity.

B. The CxA shall develop forms similar to that in Section 23 08 00 for the Contractors use during the commissioning process. The forms shall become part of the final commissioning manual. Forms shall be provided for each piece of commissioned equipment and system. Any deviations from the design shall be noted and proved by the Owner prior to acceptance. Each form shall be signed by the Contractor, CxA and Owner prior to acceptance of a system or piece of equipment.

1.5 PROJECT OBSERVATIONS

A. The CxA shall perform observations of the commissioned equipment and systems twice a month at a minimum and more as required to keep pace with construction. The CxA shall note progress and any deviations of the construction documents shall be brought to attention of the Contractor and Owner for resolution. The CxA will have no authority to direct changes or corrections to the system. Observation reports shall be published to the Owner, Architect and Contractor and shall be part of the final commissioning manual.

1.6 OPERATIONAL AND START-UP TESTS

A. The CxA shall witness start-up tests and collect documentation of the tests. The CxA shall notify the Architect and Contractor of any deviations from the contract documents. Any deviations shall be corrected or accepted by the Owner prior to acceptance.

B. After the Contractor has submitted in writing that the systems are completed, the CxA shall schedule and direct operational tests of the systems. These tests shall be as described in Section 23 09 00 and 23 08 00. The results shall be documented and made part of the commissioning manual. Any deviations from the design shall be brought to the attention of the Architect and Contractor. Any deviations shall be corrected or accepted by the Owner prior to acceptance.

1.7 COMMISSIONING MANUAL

A. The CxA shall prepare the final commissioning manual. The manual shall provide a complete history of the commissioning process and shall include:

1. Design and Energy Codes.
2. Commissioning Plan.
3. Completed Commissioning Forms.
4. Completed Observation Reports.
5. Completed Start-up Reports.
6. System Operational Tests.
7. Final sequence of operation to be achieved.
8. Summary of building operation as commissioned, noting deviations from design.
9. Design Criteria (extended from Design Documents by CxA).
10. Written summary of normal startup and operating procedures for each commissioned item of equipment.

The manual shall be a three ring binder with tabs for each section. Provide 5 copies.

END OF SECTION 23 08 01

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This Section covers water piping carrying water at 200ºF or less, used in the following systems:

1. Condensate drain system
2. Condenser water system

1.2 SUBMITTALS

A. Detailed piping shop drawings, which include sizes, layouts, and materials, must be properly submitted. Any piping installed without prior written approval by the engineer of record shall be replaced at the expense of the contractor.

B. Submit manufacturer's product data on the following:

1. Strainers
2. Expansion tanks
3. Air purgers
4. Air vents
5. Pressure temperature taps
6. Balancing valves
7. Thermometers
8. Pressure gauges
9. Relief valves
10. Glycol

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Size 2" and Smaller: Any of the following:

1. Steel pipe, Schedule 40 with 125-lb. cast iron threaded fittings (ASTM A-53).
2. Copper tube, hard temper, Type L with wrought copper fittings.

    a. Solder for copper tube joints:

        1) 30 psig to 175 psig: 95-5 tin antimony.
        2) Above 175 psig: Brazed joints.

    b. Grooved Copper

B. Size 2½" and Larger: Steel pipe (ASTM A-53), standard schedule, with any of the following fittings:

1. Black steel standard weight butt weld.
2. 125-lb cast iron flanged.
3. Malleable or ductile iron grooved pipe fittings, designed for roll or cut grooved joint (grooved piping 24" and larger to be Schedule 40).

2.2 PREINSULATED/BURIED PIPE

A. Pipe Materials: Pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight indicated for each service.

B. Pipe/Tube Fittings: Factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size.

C. A preinsulated piping system consists of carrier pipe, insulation, protective jacket, connectors, supports and appropriate fittings.

D. All straight sections, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. One square cut, plain end for field cutting and beveling is allowed per straight run of pipe. Other ends shall be factory square cut and factory beveled such that the field welds have the capability of being welded to pass x-ray testing.

E. The system design shall be in strict conformance with ASME/ANSI B31.1, latest edition, and stamped by a registered professional engineer.

F. Manufacturers:

1. Perma-Pipe
2. Thermal Pipe System
3. Thermacor

G. Accessories:

1. End seals, fittings and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system during shipping, outdoor storage, installation and operation. End caps on the ends of the service pipe are required to prevent debris from entering the pipe for the period of time up until installation.

H. Protective Jacket:

1. All straight sections of the factory preinsulated piping system shall be jacketed with a High Density Polyethylene jacket conforming to ASTM D1248. PVC jackets shall not be allowed.
2. All HDPE jacketing material shall have minimum wall thickness as specified below. The wall thickness shall not be less than indicated in these specifications.

Jacket O.D.	Jacket Thickness
O.D. ≤ 12”	0.125”
12”, O.D. ≤ 24”	0.150”
O.D. 24”	0.175”

3. All fittings of the factory preinsulated piping system shall be jacketed with the same material used for the straight sections of pipe and prefabricated to minimize field joints. Fittings shall be jacketed using a molded HDPE cover over polyurethane foam. Fittings shall be waterproof from the factory without the use of any type of tape, cellophane (or other non-HDPE plastic) wrap, mastic, glue or hot air welds.

I. Field Joints:

1. All field joints shall be made in straight sections of pipe. Field joints other than at straight sections shall not be acceptable.
2. The method of field joint closure is as follows:

    a. The field joints are pressure tested and inspected for leaks.
    b. A split sleeve with holes in the top is placed around the joint area and secured with straps and sealed to the jacket with tape.
    c. Two-part polyurethane foam is mixed properly and poured into the holes on the top of the split sleeve.
    d. After the foam insulation has expanded and cured, any excess foam shall be removed.
    e. An adhesive backed heat shrinkable sleeve is then placed around the field joint area making sure to overlap the sleeve onto the HDPE jacketing by at least 3” on each

side. This 3” overlap is to be completely on the HDPE and does not include the length of overlap of the split sleeve or tape.

f. Heat is applied using a rosebud torch to the heat shrinkable sleeve slowly and evenly across the length of the sleeve until the sleeve has drawn tight.
g. Any spots that pucker up during the shrinking process shall be covered with a thick-bodied asphaltic mastic (black roofing compound).
h. Backfilling of the trench shall not begin until the area has cooled to the touch.

3. The piping systems manufacturer shall furnish all the foam insulation, split sleeves and heat shrinkable jacketing materials for making the field joints. The contractor shall furnish the straps, tape, knives, saws, torch, gas and mastic materials.

2.3 STRAINERS

A. Manufacturers:

1. Armstrong
2. Gruvlok
3. Hoffman
4. IMI Flow Design
5. Metraflex
6. Mueller
7. Sarco
8. Victaulic

B. Size 2” and Smaller: 250-lb cast iron, threaded.

C. Size 2½” and Larger: 125-lb cast iron, flanged or grooved.

D. Screens:

1. Final Screen:

a. Material: Type 304 stainless steel.
b. Perforations: 0.045” diameter, 233 holes per square inch.

2. Roughing Screen:

a. Material: Carbon steel.

3. Provide roughing screens at all circulation pumps and at any additional strainers upstream of primary plant equipment such as boilers, chillers, etc.

2.4 EXPANSION TANKS

A. Manufacturers:

1. Amtrol
2. Apollo
3. Armstrong
4. ITT Bell & Gossett
5. John Wood
6. Taco
7. Wessels

B. Type: Bladder.

C. Design Max. Temperature: 150F

D. Design Min. Temperature: 40F

E. Maximum working pressure: 125 psi

F. Design pre-charge pressure: 12 psi

G. Bladder Material: EPDM, compatible with propylene glycol.

2.5 AIR PURGERS

A. Manufacturers:

1. Amtrol
2. Armstrong
3. ITT Bell & Gossett
4. Spirotherm
5. Taco
6. Thrush

B. Model: ITT Bell & Gossett 107A

C. Float actuated, non-modulating, rated at 175 psig at 150 ºF and 150 psig at 250ºF.

2.6 AIR VENTS

A. Manufacturers:

1. Amtrol
2. Armstrong
3. ITT Bell & Gossett

4. Spirotherm
5. Taco
6. Thrush

B. Resilient Parts: EPDM

C. Vents on Pipes Size 2” and Smaller: ITT Bell & Gossett Model 4V

D. Vents on Pipes Size 2½” and Larger: ITT Bell & Gossett Model 107A

E. Vents on Air Purgers: ITT Bell & Gossett Model 97

F. Automatic Air Vents: ITT Bell & Gossett Model 97

2.7 PRESSURE TEMPERATURE TAPS

A. Manufacturers:

1. Omega
2. Petes Plug
3. Sisco
4. Trerice
5. Watts

B. Construction:

1. Body and Cap: Brass
2. Pressure: 500 psig
3. Temperature: 350ºF
4. Core: EPDM, self-sealing.
5. Cap: Gasketed, threaded.
6. Size: 1/4” NPT or 1/2” NPT.

C. Thermometer:

1. Dial diameter: 2”
2. Range: 0º to 220º

D. Pressure Gauge Adapter:

1. Model: GA-125

E. Pressure Gauge:

1. Dial diameter: 4½”
2. Range: 0 to 100 psig
3. Accuracy: ½%

2.8 BALANCING VALVES

A. See Section 23 05 23.

2.9 THERMOMETERS

A. Manufacturers:

1. Dwyer
2. Ernst
3. Marsh
4. Trerice
5. Winters

B. Housing: 9” adjustable angle stem.

C. Tube: Lens front, red or blue liquid.

D. Range:

1. Chilled water, condenser water, 0ºF to 100ºF.
2. Hot water, 30ºF to 240ºF.

2.10 PRESSURE GAUGES

A. Manufacturers:

1. Dwyer
2. Ernst
3. Marsh
4. Trerice
5. Winters

B. Construction:

1. Liquid filled.
2. Minimum 3 1/2” diameter face with 270 degree arc.
3. Range: As required to keep normal operating point in mid 2/3 to 3/4 of dial.

    a. Use 30” vacuum to 100 psi gauge for pumps designed to operate at pressures up to 75 psig total pressure. (Total pressure = required pump-off static pressure plus scheduled pump head).

4. Use higher pressure ranges as required such that scheduled total pressure does not exceed an operating point above ¾ range of dial.

C. Accuracy: 1% of full scale over middle of range.

2.11 AIR SEPARATORS

A. Manufacturers:

1. Amtrol
2. Armstrong
3. ITT Bell & Gossett
4. John Wood
5. Spirotherm
6. Taco
7. Wessels

B. Constructed and nameplated for 125 psig working pressure and stamped in compliance with ASME boiler and pressure vessel code.

C. Provide blow-down connection.

D. Provide integral strainer.

2.12 RELIEF VALVES

A. Manufacturers:

1. Apollo
2. ITT Bell & Gossett
3. Kunkle
4. Spence
5. Taco
6. Thrush
7. Watts

B. Type: ASME

C. Size: Maximum input capacity of system at design pressure.

D. Setting: Operating pressure of system plus 2 psi unless otherwise noted.

2.13 PROPYLENE GLYCOL

A. Manufacturers:

1. Dow Chemical Company
2. Dupont
3. Dynalene
4. Interstate Chemical Company, Inc.

B. Model: Dow Chemical Company Dowfrost

C. Type: Propylene Glycol with corrosion inhibitors. For glycol concentrations less than 30%, provide additional inhibitors per manufacturer's recommendations for adequate corrosion and microbial growth protection. Added inhibitors must be compatible with the glycol and its inherent inhibitors.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. Install horizontal piping level (except drain piping and as otherwise noted) and parallel to building construction. All vertical piping to be plumb.

B. Make any changes in direction with fittings, do not kink or bend piping. Elbows are to be long radius type wherever possible.

C. Where pipes pass expansion joints or structural elements subject to movement, provide flexible expansion compensators and supports or piping expansion loops to allow for movement without adverse effects.

D. Regardless of how shown on schematic piping diagrams, do not install a tee so that flow enters from opposite directions.

E. Do not rearrange piping in a manner to increase pressure drop without written approval from Architect/Engineer.

F. Install drains at all low points of the system.

3.2 EQUIPMENT CONNECTIONS

A. Do not allow weight of piping or expansion of piping to put stress on equipment connections.

B. Pipe equipment to allow for servicing (coil pull, tube pull, etc.) with minimum of disruption to piping.

C. Provide unions or flanges at all equipment connections.

3.3 FREEZE PROTECTION

A. Fill systems with indicated solution by volume of propylene glycol and water.

B. Pre-mix all solutions before injection into system.

3.4 AIR VENTS

A. Install automatic air vents at high points in equipment rooms.

B. Install manual air vents at high points not in equipment rooms.

3.5 RELIEF VALVES

A. Install pressure relief valves on all vessels, which may be isolated from other relief valves by closing valves. Pipe discharge full size to nearest floor drain.

3.6 PRESSURE TEMPERATURE TAPS

A. In Pipes 2” and Smaller: Install taps in tee at change in direction so inserted thermometer stem will be parallel to center line of pipe.

1. Add extra change in direction if necessary.
2. Allow clearance for insertion of thermometer.
3. Insure that gauge or thermometer will be in a readable position.

3.7 HOT TAPS

A. Hot taps are to be used only after written permission by the Architect/Engineer. Submit intended procedure with request.

3.8 CLEANING

A. Flush the system thoroughly with clear water.

1. Drain system.
2. Clean all strainers.

B. Refill system with solution of 1 lb. trisodium phosphate to 50 gal of system water.

1. Heat system to design temperature.
2. Circulate as required to fully clean the piping system. Continuously check strainers and verify they have been clean for a minimum of two hours.
3. Stop circulation and drain system.
4. Clean all strainers.

C. Fill system with fresh water or water/glycol mixture.

3.9 CORROSION PROTECTION

A. Provide dielectric unions at unions between piping of different materials.

B. See Section 23 25 13 for water treatment program to be provided.

C. All components of system shall be compatible with propylene glycol and water solution.

3.10 PREINSULATED/BURIED PIPE

A. Provide closed cell insulation, seal joints with waterproof mastic. Minimize joints below grade.

B. Provide thrust blocks at all changes in direction for pipe 8” and larger.

C. Comply with Division 2 and Section 23 05 03 for excavation and backfill requirements.

D. The installing contractor shall handle the system in accordance with the directions furnished by the manufacturer and as approved by the engineer.

E. A minimum of six inches (6”) of sand or fine gravel bedding shall be placed all around the pipe in the trench. This bedding/fill shall be hand tampered and compacted around the pipes in six-inch (6”) lifts until the fill is six inches (6”) above the top of the jacketing material. The remaining height of the trench shall be evenly and continuously backfilled and compacted in uniform six-inch (6”) lifts with suitable clean excavated soil.

3.11 PRESSURE GAUGES

A. Pump assemblies: Use a single gauge with multiple taps to pumped system (strainer inlet, strainer outlet, pump suction and pump discharge) per the detail on the drawings.

B. Allow clearance for removal of gauge.

C. Insure that gauge will be in a readable position.

END OF SECTION 23 21 13

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

A. Construct ductwork to meet all functional criteria defined in Section 11 of the 2005. SMACNA "HVAC Duct Construction Standards, Metal and Flexible", Third Edition. Comply with SMACNA recommendations for fabrication, construction and details, and installation procedures, except as otherwise indicated.

B. Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), except as otherwise indicated.

C. Comply with SMACNA "HVAC Air Duct Leakage Test Manual" for testing of duct systems.

1.2 SUBMITTALS

A. Detailed ductwork shop drawings, which include sizes, layouts, and pressure classifications, must be properly submitted. Any ductwork installed without prior written approval by the engineer of record shall be replaced at the expense of the contractor.

B. Shop Drawings: Submit shop drawings for:

1. Transition elbows.
2. Seal and reinforcing schedule for all ductwork fabrication types.
3. Turning vane and turning vane installation.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

A. All interior ducts shall be constructed with G-90 or better galvanized steel (ASTM A653/653M) LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions (i.e. kitchen exhausts) shall also be G-90 or better galvanized steel LFP, chem treat.

2.2 RECTANGULAR DUCT

A. Construct rectangular ductwork to meet all functional criteria defined in Section 11, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2005 Edition. All ductwork must comply with all local, state and federal code requirements.

B. Where the standard allows the choice of external reinforcing or internal tie rods, only the external reinforcing options shall be used.

C. Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.

D. Ductmate or W.D.C.I. proprietary duct connection systems will be accepted. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.

E. Formed on flanges (T.D.C./T.D.F./T-25A/T-25B) shall be constructed as SMACNA T-25 flanges, whose limits are defined on Page 2.76 2005 SMACNA Manual, Third Edition. No other construction pertaining to formed on flanges will be accepted. Formed on flanges shall include the use of corners, bolts and cleat.

F. Ductmate type systems that use a butyl Rubber Gasket which meets Mil-C 18969B, Type II Class B, TT-C-1796 A, Type II Class B, and TTS-S-001657 must also pass UL-723. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth (as defined in 21CFR 177, 1210 closures with sealing gaskets for food containers).

G. Fittings shall be constructed and reinforced as ductwork according to the longest span.

2.3 ROUND AND OVAL DUCT

A. Round and oval duct shall be galvanized steel, constructed in accordance with Section 11 of the 2005 SMACNA “Duct Construction Standards, Metal and Flexible”, except as noted.

1. Lighter gauge factory made duct with an Intermediate standing rod may be used. Submit product data sustaining the equivalency of such duct into SMACNA standard duct.

B. Minimum duct gauge shall be 26 gauge.

C. Round ductwork shall be spiral lock seam construction only. Longitudinal seam duct is not acceptable. Gauges shall be in accordance with SMACNA Duct Construction Standard and fittings in accordance with SMACNA Duct Construction Standard, except as noted:

1. Joints 0”-20” diameter, interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3-inch wide duct tape.
2. Joints 21”-72” diameter, use 3-piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Example: Ductmate Spiralmate or equal.

3. Joints 73” diameter and up, use companion angle flanged joints only as defined on page 3-6 of the SMACNA Manual. Refer to manual for proper sizing and construction details. Ductwall to be welded longitudinal seams.

D. Fittings shall be continuously welded, standing seam, or spot welded and sealed. Metal thickness and reinforcing shall be equivalent to the requirements of the largest span.

1. All elbows greater than 45” shall be radius type, R=1.5 times duct diameter.
2. Elbows less than 6” shall be of die stamped construction. Elbows 6” or greater shall be 5-gore construction.
3. Diverging and converging flow fittings shall be constructed with no excess material projecting from the body into the branch tap entrance. All such fittings shall be 45° “shoe” entrance, wye plus elbow, or 45° lateral branch. Special fittings such as heel tapped elbows and bullhead tees may be used only where shown on drawings. Adjustable elbows and straight saddle taps shall not be used. Low pressure adjustable elbows acceptable.

E. Where round ductwork 24” and smaller is indicated to be in areas exposed to view, utilize one of the following transverse joining methods:

1. Beaded sleeve connections with duct sealant applied to the sleeve joint prior to attachment.
2. Beaded sleeve connections with gasket integral to sleeve.
3. No sealant shall be visible on the outside of the duct.

F. Where round ductwork over 24” is indicated to be in areas exposed to view, utilize Van Stone flange joints with non-extruding gasket. No sealant shall be visible on the outside of the duct.

2.4 CONTRACTOR FABRICATED CASINGS AND PLENUMS

A. Unless required otherwise by drawings, single wall casings and plenums may either be contractor or factory fabricated where shown on drawings. All double wall casings and plenums shall be factory fabricated.

B. Casings and plenums shall be constructed in accordance with the 2005 SMACNA “HVAC Duct Construction Standards,” Third Edition and as specified below.

C. All casings and plenums on the suction side of any fan, including return air outside air, or mixing plenum shall be constructed to 2” negative pressure class.

D. Louver blank-off panels shall be constructed to 2” negative pressure class.

E. All casings and plenums for relief and exhaust air shall be 2” positive or negative pressure class.

F. All casings and plenums on the discharge side of supply fans shall be 4” positive pressure class.

G. Single wall plenums shall be of the standing seam type construction. Submit shop drawings indicating overall dimensions, support details, corner and edge details, penetration details, equipment installation details, and pressure class.

H. Seal all seams, edges, and corners with approved duct sealant.

I. Casing materials shall be the same as that for the connected duct systems.

J. Where automatic dampers may, completely shut off air flow and subject plenum of casing to fan close off pressure, install pressure relief panels, rated to open at 125%.

2.5 MISCELLANEOUS DUCTWORK MATERIALS

A. General: Provide miscellaneous materials and products of the types and sizes indicated, and where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Double wall turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct. Tab spacing shall be SMACNA standard. Rail systems with non-standard tab spacings shall not be accepted. All tabs shall be used, do not skip tabs. Mounting rails shall have friction insert table, which align the vanes automatically. Vanes shall be subjected to tensile loading and be capable of supporting 250 lbs., when fastened per the manufacturer's instructions. Approved Systems: Ductmate PRO-Rail.

C. Single wall splitter and turning vanes shall be custom fabricated as specified below.

D. Ductwork Support Materials: Except as otherwise indicated, provide galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

E. Duct Sealant:

1. Manufacturers:

    a. Childers CP-146 Chil-Flex
    b. CL Ward S Seal
    c. Design Polymerics 1010
    d. Ductmate PROseal
    e. Hercules Industries MTS200

2. Description: Non-hardening, water based, liquid or mastic elastic sealant with UV inhibitors for outdoor use
3. UL Listings: UL 181B-M and UL 723/ASTM E84.
4. Sealants shall contain no VOCs.

F. Duct Tape Sealing System:

1. Manufacturers:

   a. Design Polymerics
   b. Hardcast.
   c. Approved equal

2. Model:

   a. Tape: Hardcast DT
   b. Indoor Adhesive: Hardcast FTA-20
   c. Outdoor Adhesive: Hardcast RTA-50

G. Acoustical Duct Lagging:

1. Manufacturers:

   a. Acoustical Solutions
   b. Kinetics Noise Control
   c. Sound Seal

2. Model: Sound Seal B-10 LAG/QFA-3, foil face loaded vinyl or lead barrier sheet fully bonded to a minimum 1" thick fiberglass blanket, nominal density of 1.0psf, install so jacket edges overlap by minimum of 6", minimum STC-27 tested by independent laboratory in accordance with ASTM E90 and E413, minimum insertion loss (IL) value at 500Hz shall be 23 and meets IMC flame/smoke ratings in accordance with ASTM E84.

H. Fiberglass ductboard is not accepted without prior written approval from the specifier.

I. Access doors shall be hinged or Ductmate Sandwich Type Access Doors manufactured by Ductmate Industries, Inc. Doors shall be of adequate size to allow easy access to hardware, which needs to be maintained.

J. Flexible Duct Connector:

1. Flexible duct connector shall be used where ductwork connects to fans of apparatus, or apparatus casing to fans.
2. Connectors will meet NFPA 90A and 90B specifications and provide an airtight and waterproof seal.
3. Indoor installations shall be Neoprene or vinyl coated fabrics.
4. Outdoor installations shall use Hypalon coated fabric.
5. Connector shall be Ductmate PROFlex or approved equal.

2.6 FABRICATION

A. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 2005 Edition. This shall be subsequently referred to as the SMACNA Manual. All ductwork must comply with all local, state and federal code requirements.

B. All "medium pressure" (systems with external pressures greater than 2" w.c.) duct systems shall be constructed for 4" W.C. positive and 1" W.C. negative static pressure and 3500 FPM velocity.

C. See air handler and fan schedules for external pressure requirements. All pressures above 2" E.S.P. shall be medium pressure.

D. All low-pressure ductwork is to be constructed for 2" W.C. positive and 1" negative static pressure and 2000 FPM.

E. All negative pressure ductwork shall be constructed for a minimum of 2" W.C. negative and 2" W.C. positive static pressure and 2000 FPM velocity.

F. Make all changes in direction using 1.5 radius elbows where possible. Use splitter vanes or mitered rectangular elbows with turning vanes otherwise.

1. Use single thickness splitter vanes for all radius elbows less than 1.5 D = r.

    a. D = diameter of duct or width of duct (in plane of change-in-direction).
    b. r = radius of duct at duct center-line.
    c. Use "Curve Ratios" of 0.45 or greater (as defined by figure 3-7 of the 1989 ASHRAE Fundamentals Handbook).

2. Use single thickness turning vanes with no trailing edges in accordance with SMACNA Standards.

    a. All mitered, rectangular elbows in series.
    b. All mitered, rectangular elbows less than 36" in width (in plane of change-of-direction).

3. Use double width, airfoil type turning vanes with no trailing edges for all rectangular elbows greater than 36" in width (in plane of change-of-direction).

    a. Isolated elbows have a minimum of 3D straight duct upstream and downstream of the change-in-direction.

G. Fabricate transition elbows with turning vanes at correct angle so entering and leaving edges are parallel or tangent to air flow.

H. All branch duct take-offs shall use 45° laterals or 45° "pants-leg" type fittings.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

A. Assemble and install ductwork in accordance with recognized industry practices, which will achieve air-tight and noiseless systems, capable of performing each indicated service.

B. Install each run with a minimum of joints.

C. Where ducts pass expansion joints or structural elements subject to movement provide flexible connections and supports to allow for movement without adverse effects.

D. Align ductwork accurately at connections, within 1/8” misalignment tolerance and with internal surfaces smooth.

E. Support ducts rigidly with suitable ties, braces, hangers and anchors of the type, which will hold ducts true-to-shape to prevent buckling. This Division is responsible for all duct supports.

F. Seal ducts in accordance with SMACNA requirements for pressure class indicated. Refer to duct leakage testing requirements for required seal class.

1. Indoor Ducts: Use liquid or mastic sealant, or tape system.
2. Outdoor Ducts: Use tape system.
3. Approved manufactured joining systems with gaskets may be used in lieu of transverse sealing.

G. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible.

H. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building.

1. Limit clearance to 0.5” where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.
2. Where possible, locate insulated ductwork for 1.0” clearance outside of insulation.

I. In finished spaces, conceal ductwork by locating in mechanical shafts, hollow wall construction or above suspended ceilings.

J. Where possible, avoid locating ducts on or near floor.

1. Where ducts must be located low, provide metal trestle to protect duct at places where duct will be climbed over.

K. Coordinate the layout with suspended ceiling and lighting layouts and similar finished work.

L. Install access doors where necessary for inspection and maintenance.

1. Provide additional 12” x 12” access door at each low leakage damper.
2. Arrange access doors so that:

    a. They open against the system air pressure wherever feasible.
    b. Their latches are operable from either side, except where the duct is too small to be entered.

3. Provide access doors at all fire damper locations.

M. Where ducts pass through non-fire-rated interior partitions below ceiling and exterior walls:

1. Conceal the space between the construction opening and the duct or duct-plus-insulation with sheet metal flanges of the same gauge as the duct.
2. Overlap the opening on all sides by at least 1-1½”.

N. Provide volume dampers at branch take-offs (except upstream of VAV boxes which should not have dampers).

O. Provide conical or tapered taps with balancing dampers on all round ductwork takeoffs (except upstream of VAV boxes, which should not have dampers).

P. Where space permits, round or oval ductwork of equivalent diameter may be substituted for unlined rectangular ductwork.

Q. Do not modify ductwork in a manner that will increase external static pressure in the system without written approval from Architect/Engineer.

3.2 DUCT LEAKAGE TESTING

A. Installed ductwork shall be tested prior to installation of access doors, take-offs, etc.

B. All leak testing shall be witnessed by the Engineer or representative of the Engineer. The Contractor shall give the Engineer 72 hours’ notice prior to testing. Any testing not witnessed by the Engineer or their representative, shall be considered invalid and will be redone.

C. The testing shall be performed as follows:

1. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
2. Use a certified orifice tube for measuring the leakage.
3. Define section of system to be tested and blank off.
4. Determine the percentage of the system being tested.
5. Using the percentage, determine the allowable leakage (cfm) for that section being tested.
6. Pressurize to operating pressure and repair any significant or audible leaks.
7. Repressurize and measure leakage.

8. Repeat steps 6 and 7 until the leakage measured is less than the allowable defined in step 5.

D. All transverse joints and longitudinal seams shall conform to SMACNA's Class A sealing requirements as defined on page 1.17 of the 2005 SMACNA Manual, Third Edition.

E. Constant Volume Systems/Supply Ductwork
Allowable Leakage 1% of design cfm

F. Constant Volume Systems/Return Ductwork
Allowable Leakage 2% of design cfm

G. Extent of Testing

1. Test all negative pressure outside air ductwork as return air.
2. Test all positive pressure outside air ductwork as supply air.
3. All rigid ductwork to be tested to within limits defined above. Testing and any required corrective action may be conducted post-occupancy.
4. Submit duct testing reports for each individual fan system to Engineer for record.

3.3 DUCTWORK STORAGE AND CLEANING

A. Cleaning:

1. Interior surfaces shall be free of dust and debris prior to initial startup. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes. Any cleaning of duct systems shall comply with recommendations of NAIMA and NADCA.
2. When internally cleaning duct work prior to installation or shipment to the jobsite, all duct ends and openings must be covered prior to transporting with a dual Polyethylene protective film. Film must be securely affixed to protect against dirt and debris and must be translucent to facilitate inspection of interior surfaces without removing film. Film must have a minimum elongation of 600%, contain no VOC and leave no residue on duct after removal.
3. Clean external surfaces of foreign substances that might cause corrosion, deterioration of the metal, or where ductwork is to be painted.

B. Protection:

1. Store duct a minimum of 4" above ground or floor to avoid damage from weather or spills.
2. Cover all stored ducts to protect from moisture or debris.
3. Cover all ends of installed ductwork at the end of each workday or when dust and debris producing construction (such as fire proofing, drywall, sanding, or core drilling) is occurring.

C. Ductwork contaminated or damaged above “shop” or “mill” conditions shall be cleaned, repaired or replaced to the Engineer’s satisfaction.

END OF SECTION 23 31 13

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

A. Comply with SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) latest recommendations for fabrication, construction and details, and installation procedures, except as otherwise indicated.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data on the following:

1. Flexible duct
2. Fire dampers
3. Louvers

PART 2 - PRODUCTS

2.1 FLEXIBLE DUCT ACOUSTICAL

A. Manufacturers:

1. Flexmaster Type 1M.
2. ThermaFlex-MKE

B. Construction:

1. PE Liner film mechanically locked without adhesives.
2. Insulation: Minimum 1-½" thick fiberglass blanket with a polyethylene vapor barrier. Map 0.23 'c' factor, factory installed.
3. Helix: Corrosion resistant galvanized steel.

C. Pressure rating: 5" w.g. positive, 1" w.g. negative at maximum 180°F operating temperature.

D. Standards: NFPA90A UL-181, Class I, ASTM E-96 - Procedure A.

E. Insertion loss shall be at least:

	OCTAVE BAND (Hz)					
Duct Size	125	250	500	1000	2000	4000
8”	5.6	10.6	23.9	34.0	22.5	17.0
12”	6.6	27.8	22.8	29.0	18.7	10.9
	DB reduction for 6-foot length, straight route, 500 fpm.					

2.2 LOUVERS

A. Manufacturers:

1. Air Balance
2. Airolite
3. Arrow United Industries
4. AWV
5. Construction Specialties
6. Greenheck
7. Louvers & Dampers, Inc.
8. Pottorff
9. Ruskin
10. Safe-Air Dowco
11. United Enertech
12. Wonder Metals

B. Screens: 1/2” mesh, .063” aluminum wire.

C. Blades: Of depth shown by schedule, drainable.

D. Rating Basis:

1. AMCA Standard 500, based on 15-minute test of 48” x 48” louver. Provide louvers with water penetration and pressure drop no greater than specified louver, and with free area no less than specified louver.

2.3 FIRE DAMPERS

A. Manufacturers:

1. Air Balance
2. Greenheck
3. Johnson Controls
4. Nailor
5. NCA
6. Pottorff

7. Prefco
8. Ruskin
9. Safe-Air Dowco
10. United Enertech

B. Rating: UL555 dynamic 1-½ hours, or 3 hours, UL555S Class II leakage rated. Match construction penetrated.

C. Size: Metal-to-metal for lined and unlined ducts.

D. For curtain type, use Type B “Top Hat” wherever possible.

E. Integral factory-mounted access door.

2.4 MISCELLANEOUS DUCTWORK ACCESSORIES

A. Duct Access Doors: Provide duct access doors with gaskets, door hinge, and with insulation where ductwork is indicated to be insulated.

1. Manufacturers:

a. Greenheck
b. Ductmate
c. Elmdor
d. Flexmaster
e. Milcor

B. Flexible Connectors:

1. Manufacturers:

a. Cain Thermolon
b. Carlisle Connector Plus w/Silicone Hi-T
c. Duro-Dyne Thermafab
d. Ductmate PROFlex with Silicone

2. Material: Glass fabric with silicone coating.
3. Rating: ASTM E84 or UL 723

a. ASTM E84

1) Flame Spread less than 25
2) Smoke Developed less than 50

2.5 BALANCING DAMPERS

A. Construction:

1. Frame: 16-gauge galvanized steel.
2. Blades: 16-gauge galvanized steel with vinyl edge seals.
3. Bearings: Heavy duty nylon.
4. Performance:

    a. Maximum pressure drop in full open position (@3000 fpm): 0.55
    b. Maximum leakage: 32 cfm/sp at 4" W.C.

B. Type: Rectangular balancing dampers are to be opposed blade type with locking handle, unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESSORIES

A. Install fire dampers in accordance with manufacturer's instructions and the latest version of the Fire, Smoke and Radiation Damper Guide for HVAC Systems, published by SMACNA.

B. Install access doors where necessary for inspection and maintenance.

1. Provide additional 12" x 12" access door at each low leakage damper.
2. Arrange access doors so that:

    a. They open against the system air pressure, wherever feasible.
    b. Their latches are operable from either side, except where the duct is too small to be entered.
    c. Install flexible connectors at all duct connections to rotating or reciprocating machinery or equipment.

3. Provide access doors at all fire damper locations.

C. Install flexible ductwork without tight bends and free of kinks.

1. Flexible ductwork shall not be less than 4', nor exceed 8' in length.
2. Flexible ductwork shall be installed with a "minimum length of straight duct" upstream of the diffuser neck inlet. "A minimum length" shall mean a length equal to three (3) duct diameters. "Straight duct" shall mean the center-line of the duct shall be aligned with a line perpendicular to the plane of the diffuser neck opening at the center point of the opening.
3. Conform to the detail on the drawings.

D. Install all dampers.

1. Caulk damper frames to ductwork.
2. Make sure dampers are free to operate properly.

E. Provide balance dampers at branch take-off and where required to minimize balancing performed at diffuser face.

F. Provide all balance dampers as shown on plans and any additional dampers necessary to provide a balanced system meeting all sound requirements.

END OF SECTION 23 33 00

SECTION 23 34 00 - FANS

PART 1 - GENERAL

1.1 QUALITY CONTROL

A. Provide fans with AMCA performance certification and label.

1.2 MOTOR HORSEPOWER

A. Do not increase or decrease motor horsepower from that specified without written approval from Architect/Engineer. See Section 23 05 01.

1.3 SUBMITTALS

A. Manufacturer's Data: Submit manufacturer's product data including:

1. Performance
2. Size
3. Type
4. Options provided
5. Fan curves
6. Indicate Compliance with Section 1.1 where applicable.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FAN

A. Manufacturers:

1. Acme
2. Aerovent
3. Carnes
4. Cook
5. Greenheck
6. New York Blower
7. PennBarry
8. Twin City

B. Features:

1. Steel cabinet, baked enamel finish
2. Cast aluminum wheel, statically and dynamically balanced
3. Cast aluminum hub
4. Fan access sections shall be provided with gasketed seal.
5. Heavy duty pillow block bearings within fan housing with external grease fittings
6. Drive: See schedule

C. Accessories:

1. Access panel.
2. Filter housing.

PART 3 - EXECUTION

3.1 NOISE AND VIBRATION

A. Insure that fans are properly supported on vibration isolators. Reference Section 23 05 48 for Vibration Isolation Requirements.

B. Insure that flexible duct connections are properly made.

C. Check fan for improper balance.

1. Have fan re-balanced if necessary.

D. Check for proper rotation.

E. Check for unusual noise or vibration and correct as necessary.

3.2 ACCESS

A. Provide for proper access to all parts of fan needing inspection or service with access doors in fan or ductwork.

3.3 INSTALLATION

A. Install units level and plumb.

B. Provide necessary auxiliary supporting steel.

C. Mount motor and drives so belts run true.

D. Provide necessary lubrication.

E. Provide flexible duct connections on inlet and discharge.

END OF SECTION 23 34 00

SECTION 23 37 00 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 CEILING CONSTRUCTION

A. Provide products compatible with ceiling construction.

1.2 SUBMITTALS

A. Submit catalog data including throw, sound, pressure drop and physical dimensions.

1.3 INDUSTRY STANDARDS

A. Provide products tested in accordance with ASHRAE 70-1991 150 Standard 5219, 150 Standard 3741.

PART 2 - PRODUCTS

2.1 GRILLES AND RECTANGULAR DIFFUSERS

A. Manufacturers:

1. Krueger
2. Metal Aire
3. Nailor
4. Price
5. Titus

B. Material: Steel or aluminum except:

1. Where noted otherwise.
2. Where required otherwise for fire rating.
3. Grilles and diffusers in locker rooms, showers and toilet rooms in locker rooms to be aluminum.

C. Finish: Baked white enamel except where noted.

D. Refer to the Drawings for required performance.

E. Match frame and border types to ceiling system.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to architectural reflected ceiling plan for exact locations and ceiling types.

B. Provide all support and framing devices necessary.

C. Exposed mounting screws:

1. Use tamper proof screws in countersunk holes.
2. Point screws to match frame.

D. Fire Rated Ceilings:

1. Provide insulation equivalent to ceiling construction above diffuser between ceiling opening and ceiling damper.

E. Install security type devices in accordance with manufacturer's directions.

END OF SECTION 23 37 00

SECTION 23 40 00 - AIR CLEANING

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's product data including:

1. Media:

    a. Description
    b. Efficiency
    c. Test method

2. Enclosure
3. Support requirements
4. Weight
5. Electrical data
6. Drawings showing dimensions

1.2 QUALITY CONTROL

A. All filters shall be listed as class II per UL Standard 900.

PART 2 - PRODUCTS

2.1 2" MERV 8 PANEL FILTERS

A. Maintenance:

1. Air Guard Type DP/DP Max
2. American Air Filter PrePleat 40 LPD
3. Camfil Farr 30/30

B. Media and Performance:

1. Non-woven cotton/synthetic
2. MERV 8 filter efficiency per ASHRAE Standard 52.2-2012.
3. Clean filter efficiency of 23% at one micron.
4. Not less than 2.5 square feet of media area per square foot of filter face area.
5. No more than 0.31" WG initial resistance at 500 FPM.
6. Capable of 1.0" WG final resistance.

C. Support

1. Welded wire grid to maintain radial pleats.
2. Beverage board frame and diagonal supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate filter banks to allow for access and prevent interference or damage by other components such as dampers and humidifiers.

B. Provide vertical and horizontal stiffening bars, blank offs, angle flashing as necessary to install built up filter banks in plenum. Gasket or caulk between frame members, flashings, and blank offs.

C. Provide filter gauges to measure pressure drop of all filter banks with 2” MERV 8 filters.

D. Provide and install a clean set of filters in all equipment prior to turn over to owner and one spare filter for each unit. For units with multiple filters provide a spare filter for each type.

END OF SECTION 23 40 00

SECTION 23 81 23 - ELECTRONIC ROOM AIR CONDITIONING UNIT

PART 1 - GENERAL

1.1 FLAME-SMOKE RATINGS

A. Except as otherwise indicated, provide air-handling unit thermal insulation with flame-spread rating of 25 or less, fuel-contributed of 50 or less, and smoke-developed rating of 50 or less.

1.2 ARI CERTIFICATION

A. Provide equipment rated in accordance with ARI Standard 210, and bearing ARI certification label.

1.3 SUBMITTALS

A. Submit manufacturer's data, including:

1. Capacity.
2. Drawings showing overall dimensions of complete assembly.
3. Operating weights.
4. Equipment support requirements.
5. Sizes and locations of connections.
6. Accessories.
7. Auxiliary support requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Vertiv/Liebert

B. Schneider/APC

C. Stulz

2.2 COMPUTER ROOM AIR CONDITIONING SYSTEM

A. General:

1. The computer room environmental control units shall be self-contained, factory assembled.
2. Units shall meet UL standards, and shall be in compliance with NEC and local building department authorities.
3. Manufacturer to provide maintenance for entire computer room system for a period of (1) year from date of acceptance. This should include bi- monthly visits of 3.5 hours minimum to perform all preventative maintenance items as recommended by the equipment manufacturer, including replacement of filters, cleaning of humidifier, and parts as required. Manufacturer to provide 4 hours of training for the Owner's Representative, followed by an additional 2 hours of follow-up training within the first year.

2.3 INDOOR DX AIR CONDITIONING UNIT

A. Enclosure:

1. Material: Steel, zinc coated.
2. Finish:
    a. Baked enamel.
    b. Color selected by Owner from manufacturer's standard colors.
3. Insulation:
    a. Material: Fiberglass.
    b. Thickness: ½"
    c. Protection: Mat or foil faced.
4. Air Delivery: Downflow configuration with floor stand and front-facing discharge grille. Top return configuration.

B. Filters:

1. Type: 2" MERV8

C. Evaporator Fan:

1. Type: Backward curve, centrifugal.
2. Drive: Direct drive, electronically commutated.
3. Bearings: Self-aligning, 100,000 hour.
4. Balancing: Static and dynamic.

D. Compressors:

1. Type: Semi-hermetic.
2. Quantity: One, with hot gas bypass.
3. Mounting: Vibration isolators.
4. Protection:

    a. Over-temperature.
    b. Over-current.
    c. High pressure.

E. Refrigeration System:

1. Refrigeration circuit shall include hot gas mufflers, liquid line filter dryers, refrigerant sight glass with moisture indicator; adjustable, external equalized expansion valves, and liquid line solenoid valves.

F. Evaporator and Glycol Coil:

1. Material:

    a. Tubes: Copper.
    b. Fins: Aluminum.

2. Drain Pan: Stainless steel.

G. Condensers:

1. Type: Counter-flow.
2. Construction: Shell and tube, removable heads.
3. Certification: ASME, 400 psig at 300ºF maximum operating condition.

H. Controls:

1. Manufacturer’s standard, factory-wired.

I. Accessories:

1. Condensate Pump:

    a. Packaged unit.
    b. Automatic control.

2. Floor stand:

    a. Integral double-deflection supply grille

3. Liquid detector:

    a. Solid state water sensor and alarm.

4. Disconnect:

    a. Non-fused.

5. Four-year extended compressor warranty.

J. Control:

1. The control system shall allow programming of the following room conditions:

    a. Temperature Setpoint (65-85ºF).
    b. Temperature Sensitivity ±ºF in 0.1ºF increments).
    c. All setpoints shall be adjustable from the individual unit front monitor panel or a site monitoring device.
    d. Temperature and Humidity Sensors shall be capable of being calibrated using the front monitor panel controls to coordinate with other temperature and humidity sensors in the room.
    e. The control system shall also be capable of predictive control of temperature.
    f. Temperature Anticipation. The microprocessor shall have the capability of responding to varying rates of temperature change in the computer room. The control system shall delay cooling in response to rapid temperature changes.

2. In addition, the system shall provide the following internal controls:

    a. Compressor Short Cycle Control.
    b. Automatic Compressor Sequencing. The microprocessor shall automatically change the lead/lag sequence of the compressors after each start to lengthen compressor-on cycles and even compressor wear.
    c. System Auto-Restart. For start-up after power failure, the system shall provide automatic restart with a programmable (up to 10 minutes) time delay.
    d. Sequential Load Activation during start-up, or after power failure, the microprocessor shall sequence operational load activation to minimize inrush current systems allowing multiple loads to start simultaneously are unacceptable.

3. Control Panels:

    a. The microprocessor shall provide a local monitor panel to display operation status alarms and permit calibration and programming of operation parameters. All indicators shall be in language form. No symbols or codes shall be acceptable.

b. Provide a lead/lag control to provide the following sequence of operation:

1) Lead AC unit operates according to unit's integral control system. Lead AC unit is selected by switch on panel face, indicator lights on panel face indicate which unit is in operation.
2) If lead unit should not be able to keep up with system demand and space temperature rises above setpoint (72°F adjustable), lag unit will start automatically, unit failure alarm can be silenced by pressing the alarm silence switch on panel face. Both units will remain in operation until reset by pressing the system reset switch on panel face.
3) If lead or lag unit should fail, both units will start automatically, unit failure light on panel face will illuminate, and alarm will sound. Alarm can be silenced by pressing the alarm silence switch on panel face. System can be reset by pressing the system reset switch on panel face.

4. Alarms:

The microprocessor shall activate an audible and visual alarm in event of any of the following conditions:

a. High Temperature
b. Low Temperature
c. High Compressor Head Pressure
d. Loss of Air Flow
e. Audible Alarm. The audible alarm shall have adjustable volume to match the surrounding ambient sound level.
f. The microprocessor shall provide the capability of maintaining a log of system performance and environmental conditions. The following information shall be included in the log, complete with time and date:

1) Temperature (present, minimum and maximum for last 24 hours).
2) Compressor Operating Hours.
3) Alarm Occurrence.
4) Diagnostics. All electronic circuitry shall be provided with self-diagnostics in trouble shooting. Each printed circuit board shall be diagnosed reported as pass/not pass.
5) Communications. The microprocessor shall be compatible with all remote monitoring control devices. Provide the following equipment and accessories with the computer room environmental units. Accessories shall be factory installed and prewired for connection by the contractor.

2.4 OUTDOOR GLYCOL DRY COOLER UNIT

A. Housing:

1. Material: Aluminum.

B. Coils:

1. Material:

a. Tubes: Copper
b. Fins: Aluminum

C. Fans:

1. Type: Propeller
2. Drive: Direct
3. Air Flow: Up discharge

D. Expansion Tank:

1. Type: Manufacturer’s standard selection.

E. Glycol Pump:

1. Type: Manufacturer’s standard selection.
2. Quantity: Two, each sized for full-flow.
3. Protection: Weatherproof, vented enclosure for each pump.
4. Controls:

a. Factory-wired.
b. Automatic pump start/stop and rotation to equalize run-time.

2.5 LEAK DETECTION SYSTEM

A. General:

1. Provide a leak detection system interlocked with the operation of the cooling unit. Unit to shut down upon alarm.
2. System to include a controller capable of monitoring all point, zone, and cable leak detection sensors. Controller to tie into all cooling units.
3. Count and type of sensors used to be field coordinated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Provide necessary auxiliary supporting steel.

3.2 ADJUSTMENTS

A. Adjust drive for speed shown in submittal.

B. Mount motors and drives so belts run true.

C. Check motor amps.

1. Do not overload motor.

D. Check for unusual noise or vibration and correct as necessary.

E. Provide necessary lubrication.

END OF SECTION 23 81 23

SECTION 23 90 00 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:

1. Copies of all warranties
2. Operation & Maintenance Manuals
3. Required tests
4. Test and balance reports
5. Record drawings
6. Permit requirements
7. Valve tag list

B. The contractor shall compile a closeout manual which shall include:

1. A list of all required tests and a place for signoff of date completed.
2. A list of all submittals with dates of acceptance by the engineer.
3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
4. Test procedures to be used for life safety systems.
5. Project close out check list.

C. The final closeout manual shall include the following:

1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
3. Copies of all warranties.
4. Test and Balance report.

D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:

1. A list of all required tests.
2. Preliminary schedule showing major milestones for completion of the mechanical/plumbing systems.

B. Within 30 days of substantial completion submit the completed closeout manual as described in Part 1.

C. Within 2 weeks of substantial completion submit a completed “Project Closeout Check List”, and the Final Closeout Manual.

D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary – Mechanical, Plumbing and Fire Protection

☐ All required submittals have been cleaned, submitted and either been approved or modified in accordance with the Engineer’s “make corrections noted” comments. Our records indicate the following submittals are still outstanding:

☐ Clean filters installed in all units. (Install just prior to building turnover)

☐ All equipment has been started up and is functioning within manufacturers’ recommendations without any undue noise or vibration. (Submit a list of equipment with startup dates. Provide list no later than 120 days prior to project completion date).

☐ All vibration isolation has been installed and is operating properly.

☐ Duct access doors have been installed at fire dampers and are properly fire-stopped and fire dampers have been visually inspected to confirm that they are open.

☐ Access doors have been installed as required for concealed equipment, valves, controls, actuators, etc.

☐ All equipment has been installed with the manufacturers recommended service clearances and is fully accessible for required maintenance.

☐ All equipment and piping are labeled per specifications.

☐ All hydronic, gas and plumbing piping cleaned, flushed and tested per specifications. Submit testing reports for record.

- ☐ All action items are complete as listed in the action items reports. Submit a list of action items with sign off by Architect or Engineer for record. Punch list to be completed prior to turn over of building.
- ☐ Test and balance complete and report submitted and accepted by Engineer.
- ☐ Fire sprinkler system and pump tested per specifications.
- ☐ Operation and maintenance manuals submitted with table of contents and required documentation for extended warranties.
- ☐ Factory Testing documented and submitted for record.
- ☐ Record drawings submitted per specifications.

PART 2 - EXECUTION

2.1 EQUIPMENT STARTUP AND TESTING

A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

2.2 LIFE SAFETY SYSTEMS

A. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official

B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.

C. Once tested by the contractor and fully operational, the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

2.3 COORDINATION WITH OTHERS

A. The Division 21 through 23 contractor shall coordinate their requirements with the General Contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 21 through 23 systems.

2.4 PUNCH LISTS

A. The contractor shall submit in writing that the project is ready for final review by the engineer.

B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.

C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.

D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION 23 90 00

SECTION 26 05 00 - ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1, General Requirements.

B. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. Architect shall decide which is most stringent.

C. Provisions of Divisions 21, 22, 23, 27 and 28 shall also apply to the work of this section as if fully repeated here.

D. Provision indicate Section 23 05 01/26 05 01 “Mechanical and Electrical Coordination” shall also apply to the work of this section as if fully repeated here.

1.2 REGULATORY REQUIREMENTS

A. All materials shall conform to the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of the Architect and at no additional cost to the Owner.

B. The latest editions of the following standards are minimum requirements.

1. Underwriters’ Laboratories, Inc. (UL)
2. National Electrical Manufacturer’s Assoc. (NEMA)
3. American National Standards Institute (ANSI)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. International Electrical Testing Association (NETA)
6. Insulated Cable Engineer’s Association (ICEA)

C. All work and materials shall comply with latest rules, codes and regulations including, but not limited to the following:

1. OSHA.
2. National Fire Codes of National Fire Protection Assoc. (NFPA)
3. National Electrical Safety Code (NESC, ANSI C2)
4. National Electrical Code 2020 Edition with city, county and state Amendments.
5. International Building Code 2018 Edition with city, county and state Amendments.
6. 2010 ADAAG Americans with Disabilities Accessibility Guidelines.
7. All applicable Federal, state and local laws, code amendments and regulations.

D. Code compliance is mandatory. Nothing in these drawings and specifications permits work not conforming to these codes.

E. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, Contractor shall be responsible for all work required to open and restore the concealed area including all required modifications.

F. Contradictions: Where Codes are contradictory, follow the most stringent. Architect/Engineer shall determine which is most stringent.

1.3 CONTRACT DOCUMENTS

A. Drawings indicate general arrangement of circuits and locations of outlets, conduit, and other work. Information shown on drawings is as accurate as planning can determine, but not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all architectural, structural and mechanical drawings, and adjust all work to conform to all conditions shown therein. Architectural drawings shall take precedence over all other drawings. Discrepancies between different drawings or between drawings and specifications or regulations and codes governing installation shall be brought to attention of the Architect.

B. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer in writing during the Bidding Period of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

C. Follow Drawings and Specifications where they are superior to Code requirements. The more stringent of plans and drawing shall apply.

1.4 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 “Submittals” to a scale of 1/4” = 1’-0” or larger; detailing major elements, components, and systems of electrical equipment (i.e., all transformer vaults, switchgear rooms, generator rooms, electrical rooms and technology rooms) and materials in relationship with other systems, installations, and building components. Where equipment is located outdoors, prepare shop drawings indicating electrical equipment locations and exterior elements in the equipment areas. Indicate locations where space is limited for installation and access and where sequencing and coordination of

installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, and materials. Include the following:

    a. Exterior wall and foundation penetrations.
    b. Fire-rated wall and floor penetrations.
    c. Support details.
    d. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installation.
4. Underground conduit and duct bank routing.

1.5 RECORD DRAWINGS

A. Refer to Division 1 for additional requirements.

B. Maintain a blue-line set of Electrical Contract Drawings in clean, undamaged condition, for mark-up of installations which vary from the Contract Drawings. These drawings shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses. This set shall be made available for inspection by the Engineer or Architect at all times. Upon completion of the contract a set of computerized “as builts” capable of interfacing with AutoCAD software, shall be delivered to the Architect.

C. Prepare record documents in accordance with the requirements in Division 1 Section “Project Closeout.” In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior and locations of handholes and conduit stub-up locations.
2. Panelboard circuit directories reflecting all field changes.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Results of all testing performed as specified in the specification.
5. Certification of inspection from Authorities Having Jurisdiction.

D. Record the locations and invert elevations of underground installations.

1.6 OPERATING AND MAINTENANCE MANUALS

A. Refer to Division 1 for additional requirements.

B. Submission:

1. Submit an electronic copy of Operating and Maintenance Manuals prior to scheduling systems demonstration for the Owner.

C. Requirement Contents:

1. Manuals shall have either a combined file with bookmarks for each section or individual file for each section. If individual files, each digital file shall include section number and title in the file name.
2. Submittal for each section shall identify all equipment and materials installed on the project.
3. Manual to include contact information for a local supplier that can provide the specific piece of equipment.
4. Provide certificates for such items of equipment which have warranties in excess of one year.
5. Provide test results for each specification section identified herein.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Protection of Equipment:

1. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, rain, sleet, or dust. Large diameter cables may be stored on reels outside; however, all cable ends shall be waterproofed and the reels covered with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened, and made impervious to the elements.
2. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers, or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
3. Equipment damaged as a result of the above conditions shall be properly repaired at the contractor’s expense or shall be replaced at the contractor’s expense, if in the opinion of the Engineer, the equipment has been damaged to such an extent that it cannot operate properly after repairs are made.

4. All electrical enclosures exposed to construction damaged such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs, and pipe covering compound splashes, shall be completely covered and protected against damage.
5. In the event leakage into the building of any foreign material or fluid occurs or may occur, the contractor shall take all steps as described above to protect any and all equipment.
6. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape, and insulation removed in order to make the connection.

1.8 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. See also General Conditions.

B. No act, service, drawings review or construction review by the Architect or Engineer, is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

1.9 WARRANTIES

A. The warranty period is generally one year after Date of Acceptance.

1. During this period, provide labor and materials as required to repair or replace defects in the electrical systems at no cost to the Owner. Provide certificate with O & M manual submittal which guarantees same day service response to the Owner's call for such warranty service.
2. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies of O & M manual. Such equipment shall include:

    a. Optional Standby generator system including transfer switches and transformers
    b. Electrical panelboard
    c. Lighting fixtures
    d. Fire alarm system

3. Provide extended manufacturers warranties to cover one full year from Date of Acceptance if standard manufacturers' warranty ends any time prior to that date.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment and materials installed shall be new, unless otherwise specified.

B. All major equipment components shall have manufacturers' name, address, model number and serial number permanently attached in a conspicuous location.

C. All equipment shall be UL listed and bear the UL label.

D. Specifications list approved products for the project, if not listed follow substitution request process.

E. All areas directly exposed to outside air shall be considered exterior. Contractor's electrical installation, means and methods and materials used shall be appropriate for outdoor installations in these areas.

2.2 GENERAL SUBMITTAL REQUIREMENTS

A. Coordination and Sequencing:

1. After receipt of notice to proceed, the Contractor shall submit to the Architect a typed list of submittals and the scheduled date of submission. List shall include submittal number, section number and scheduled date of submission. Submittals shall be grouped and submitted in no more than ten complete packages.
2. The contractor shall not submit any shop drawings or product data that does not comply with the contract documents. Prior to submitting shop drawings, review submittal for compliance with Contract Documents and place a stamp or other confirmation thereon which states that submittals have been reviewed. Submittals without such verification will be returned disapproved without review.
3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.

B. Preparation of Submittals:

1. Refer to Division 1 requirements.
2. The Contractor shall submit for approval by the Architect data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submit product submittals on items as outlined in sections hereinafter.
3. Product submittals shall be made by specification section. All items of a section, requiring submission, shall be submitted together in one individual electronic file.

4. If two or more sections require inter-coordination (e.g., emergency generator and transfer switch; short circuit study, coordination study, electrical room layouts and electrical switchboards, fire alarm and fire command center layout), they shall be submitted at the same time. If electrical gear is submitted without electrical room layouts, short circuit study, coordination study, the submittal will be returned without review.
5. Each section shall be submitted as an individual file with section number and section name in the file name of the submittal.
6. Submittals of an entire product catalog will be rejected without review. Products to be used on the project must be indicated on cut sheets.
7. Provide cover letter in electronic file identifying project name, Contractor, Subcontractor, submittal name, date of submission, specification section, and information to distinguish it from other submittals.
8. Submittals not presented in individual electronic files or neat and legible fashion will returned "Without Action."
9. Submittals shall show Contractor's executed review and approval marking. Submittals which are received from sources other than through Contractor's office will be returned "Without Action."
10. Provide space for Architect's "Action" marking.

C. Substitutions

1. Refer to the General Conditions, which govern "Substitution" of specified equipment or materials.
2. Indicate any portions of work which deviate from the Contract Documents.

    a. Explain the reasons for the deviations.
    b. Show how such deviations coordinate with interfacing portions of other work.

3. Where substitution of materials alters space requirements indicated on the drawings, submit shop drawings indicating proposed layout of space, all equipment to be installed therein and clearances between equipment (i.e., electrical rooms). All clearances required by the National Electrical Code and applicable state and local regulations must be maintained.

D. Review Process

1. The Architect reserves the right to require a sample of any equipment to be submitted for approval and to retain its possession.
2. Refer to the individual sections for identified equipment and material for which submittals are required. In addition, provide shop drawings and product data on the following equipment:

    Electrical Power Conductors and Cables
    Grounding and Bonding
    Hangers and Supports
    Raceway and Boxes
    Underground Duct, Raceway & Manholes

Identification
Low-Voltage Distribution Transformers
Panelboards
Wiring Devices
Fuses
Generator Sets
Automatic Transfer Switches
Surge Protection Device

Do not submit on equipment or materials not requested in the specifications.

3. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
4. The shop drawing and product data review stamp notation requirements are defined as follows:

    a. "NO EXCEPTION TAKEN:" The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades are the responsibility of the contractor.
    b. "MAKE CORRECTIONS NOTED:" The reviewer indicated items observed that were not in compliance with the contract documents. The contractor shall not resubmit, but shall make corrections and provide corrected documents with the "Record Drawings."
    c. "REJECTED, REVISE AND RESUBMIT:" The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal do not relieve the contractor from meeting project schedules.
    d. "REJECTED:" The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal do not relieve the contractor from meeting project schedules.

5. If shop drawings are submitted and returned as "NO EXCEPTION TAKEN" or "MAKE CORRECTIONS NOTED" and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
6. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase "RESUBMITTAL NO. _____."
7. Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

PART 3 - EXECUTION

3.1 CONDITIONS AT SITE

A. Visit to site is required of all bidders prior to submission of bid. All bidders will be held to have familiarized themselves with all discernible conditions, and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.

B. Lines of other services and/or equipment that are damaged as a result of this work shall promptly be repaired at no expense to the Owner.

3.2 LICENSES, FEES AND PERMITS

A. Arrange for required inspections and pay all license, permit and inspection fees. Furnish a certificate of final inspections and approvals from local authority having jurisdiction over electrical installation.

3.3 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

A. Only professional quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.

B. Provide foreman in charge of this work at all times. Foremen for this work shall have had experience in installing not less than 5 such electrical systems of equal or greater complexity.

C. Where specifications call for an installation to be made in accordance with manufacturers' recommendations, a copy of such recommendations shall at all times be kept in job superintendent's office.

3.4 RELATION WITH OTHER TRADES

A. Contractor shall coordinate work of this Division with other trades to avoid conflict and to provide rough-ins and other connections for equipment furnished under other divisions that require electrical connections. Inform other trades of required clearances of accesses for or around electrical equipment to maintain serviceability and code compliance.

B. Verify equipment dimensions and rough-in requirements for Divisions 2 through 28 with provisions specified under this Section of work, and report discrepancies to the Architect in ample time to prevent delays or unwarranted changes of work.

3.5 TESTING

A. Provide all labor, materials, and equipment necessary to make required tests. Tests shall be complete and results approved before final inspection is begun.

3.6 PROGRESS OF WORK

A. Order progress of electrical work so as to conform to progress of work of other trades, and complete entire installation as soon as condition of building will permit. Assume any cost resulting from defective or ill-timed work performed under this Division.

3.7 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section “Cutting and Patching.” In addition to the requirement specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

    a. Uncover work to provide for installation of ill-timed work.
    b. Remove and replace defective work.
    c. Remove and replace work not conforming to requirements of the Contract documents.
    d. Remove samples of installed work as specified for testing.
    e. Install equipment and materials in newly installed structures.
    f. Upon written instructions from the architect, uncover and restore work to provide for Architect observation of concealed work.

3.8 SLEEVES

A. Place sleeve in forms of walls, floor slabs and partitions for passage of all conduits, pipes, and ducts installed under Divisions 26, 27 and 28. Sleeves shall be set in place a sufficient time ahead of concrete work so as not to delay that work. Install sleeves and raceways through exterior walls so as to provide a waterproof installation. All floor penetrations shall be made watertight. Conduits passing through walls shall be installed to preserve integrity of the wall rating (i.e., fire rating, sound rating, air, etc.). All penetration made through existing concrete slabs or walls shall be x-rayed and approved by Structural Engineer prior to cutting.

3.9 EXCAVATION, TRENCHING, AND BACKFILLING

A. Perform all excavation to install conduit and duct banks indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches

and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the Architect.

B. Grade the bottom of trenches to provide uniform bearing and support for conduits or duct bank on undisturbed soil at every point along its entire length. Tamp over depths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12” below invert of equipment or installation.

C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale. These materials should be free from large clods of earth and stones, deposited in 6” layers and rammed until the installation has cover of not less than the adjacent ground but not greater than 2” above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.

D. In addition, all excavation and backfilling shall comply with Division 2. The most stringent requirement shall apply.

3.10 CLEANUP

A. Remove all materials, scrap, etc., relative to electrical installations and leave premises in a clean, orderly condition. Any costs to the Owner for cleanup of site will be charged to the Contractor. At completion, all equipment, raceways, etc., shall be thoroughly cleaned and all residue removed from the inside and outside surfaces. Defaced finish shall be refinished.

3.11 TEMPORARY POWER

A. Provide temporary power as requested by the general contractor and in accordance with OSHA and local code requirements. Lighting and power outlets shall be provided throughout the project. Check with construction manager or general contractor prior to bid for special lighting and power outlets and provide as needed.

3.12 MINOR CHANGES

A. The Owner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the Owner.

3.13 ELECTRICAL SYSTEMS OPERATIONAL TESTS, CERTIFICATION, AND DESIGN AUTHORITY ASSISTANCE

A. Testing

1. Refer to the individual specification sections for test requirements.
2. Prior to the final inspection, the systems or equipment shall be tested and reported as herein specified. One electronic copy of the tests shall be submitted to the Architect/Engineer for approval.
3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers' Certifications

1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been installed in accordance with the manufacturers' recommendations and is operating as specified in the contract documents.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Architect/Engineer or their representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
2. Remove equipment covers (i.e., switchgears, switchboards, panelboard trims, panelboards, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceiling shall be removed as directed for inspection of equipment installed above ceilings. Reinstall all covers or ceilings after inspection.
3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by Architect/Engineer.
4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Architect/Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Architect. Refer to the appropriate specification section for additional testing requirements. Representatives of the emergency generator/automatic transfer switch and fire alarm systems are required for demonstrations.

3.14 COMMISSIONING

A. After startup and testing of each system has been completed, the Owner shall have an independent firm conduct detailed observations of the equipment and systems to confirm compliance with the Contract Documents.

B. The Division 26 Contractor shall include, as part of the work of his contract, costs to cover manpower, equipment, tools, ladders, instruments, etc., necessary to expedite the system performance observations.

C. The independent firm shall develop systems, equipment checkout procedures and data forms for recording compliance of the systems to the Contract Documents, performance, and construction observation lists, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

END OF SECTION 26 05 00

SECTION 23 05 01/26 05 01 - MECHANICAL AND ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 RESPONSIBILITY

A. The Divisions 21 through 23 and 26 through 28 contractor(s) shall comply with the provisions of this section. The Divisions 21 through 23 contractor(s) shall verify electrical service provided by the electrical contractor before ordering any mechanical equipment requiring electrical connections. Provide submittals of all mechanical equipment to Division 26 through 28 contractor(s).

B. The final responsibility for properly coordinating the electrical work of this section shall belong to the Divisions 21 through 23 system contractor performing the work, which requires the electrical power.

1. Each Divisions 21 through 23 contractor shall be responsible for providing power wiring for certain devices as described in the specifications and on the drawings. This work shall be provided by a licensed electrician in accordance with all of the applicable provisions of the Division 26 through 28 specifications, NEC and local codes.

1.2 WORK INCLUDED

A. Carefully coordinate the interface between Divisions 21 through 23 (Mechanical) and Divisions 26 through 28 (Electrical) before submitting any equipment for review or commencing installation

1.3 DEFINITIONS

A. Automatic: Pertaining to a function, operation, process or device that, under specified conditions, functions without intervention by human operator.

B. Disconnect Switch: A mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a power source.

C. Motor Control Center: A floor-mounted assembly of one or more enclosed vertical sections having a common horizontal power bus and primarily containing motor starting units.

D. Control Circuit/Power: The circuit which carries the electrical signals of a control apparatus or system directing the performance of the controller but does not carry the main power circuit.

E. Manual Operation: Operation by hand without the use of any other power.

F. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who furnishes motor.

G. TC: Temperature Controls = Division 23 09 00 Contractor who furnishes control.

H. EC: Electrical Contractor = Divisions 26 through 28 Contractor.

I. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Fire Alarm System.

J. EP: Electric to Pneumatic Converter.

K. PE: Pneumatic to Electric Converter.

1.4 RESPONSIBILITY SCHEDULE

A. Responsibility: Unless otherwise indicated, all motors and controls for Divisions 21 through 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	**Furnished Under**	**Set In Place Under**	**Power Wiring Under**	**Control Wiring Under**
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
AHU Interior Marine Lights	MC	MC	EC	MC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
In Motor Control Centers (Note 4)	EC	EC	EC	TC
Motor Speed Controllers: (Note 4) -Separate -Factory Mounted and Wired	 MC MC	 EC MC	 EC EC	 TC TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	EC or TC	TC
Push Button Stations, Pilot Lights	MC	EC	EC	EC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC or TC	EC or TC	EC or TC	TC
Equipment in Temperature Control Panels	TC	TC	TC	TC
Standalone Control Panels (BAS) (Note 6)	TC	TC	TC	TC

ITEM -	**Furnished Under**	**Set In Place Under**	**Power Wiring Under**	**Control Wiring Under**
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	TC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 3)	FA	FA	EC	FA
Fire Sprinkler Alarm (Note 3)	MC	MC	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	--	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	MC	EC	TC
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	FA	--	FA
Smoke Management Controls (Note 8)	FA	FA	EC	FA
Equipment Interlocks	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 7)	MC	MC	EC	FA
Smoke Control Dampers (for smoke management system)	MC	MC	EC	FA/TC
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC

Notes:

1. If furnished as part of factory wired equipment furnished and set in place by MC, wiring and connections by EC.
2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor.
3. Pre-action system initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28.
4. Electrical contractor is responsible for wiring from starter to motor unless factory wired.
5. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
6. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.

B. Power Wiring by Divisions 21 through 23: The electrical power for certain equipment provided under Divisions 21 through 23 has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21 through 23 trade requiring such power.

Sufficient power for this purpose shall be furnished as "spare" dedicated circuit capacity in Division 26's panelboards. All wiring, conduit and electrical devices downstream of the panelboards are the responsibility of the Divisions 21 through 23 trade requiring the power.

1. Such equipment is hereby defined as:

    a. Fire protection components requiring electrical power. Required connections are included in the Division 21 work, and will be shown by that contractor's engineered system design drawings.
    b. Condensate pumps. Provide power from associated unit or from nearby panelboard.

1.5 GENERAL REQUIREMENTS

A. Connections:

1. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

B. Starters:

1. Provide magnetic starters for all three phase motors and equipment complete with:

    a. Control transformers.
    b. 120V holding coils.
    c. Integral hand-off-auto switch.
    d. Auxiliary contacts required for system operation plus one (1) spare.
    e. Refer to Section 23 05 13 Motors, Starters and Drives.

C. Remote Switches and Pushbutton Stations:

1. Provide remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

D. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

E. Identification:

1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign permanently mounted to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

F. Control Voltage:

1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

G. Short Circuit Current Ratings

1. MC shall be responsible for coordinating the Short Circuit Current Ratings (SCCR) of all such equipment with the electrical short circuit study. SCCR for equipment shall be greater than the available fault current, as indicated on electrical one-lines.
2. Utilizing fuses to limit the available fault current is not acceptable.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.

1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
2. Plumbing vent piping.
3. Supply, return and exhaust ductwork.
4. Electrical conduit greater than 4” diameter.
5. Hydronic branch and mains (greater than 2”, but less than 12”).
6. Domestic water piping.
7. Fire sprinkler mains and leaders.
8. Hydronic branch piping (2” and less).
9. Domestic hot and cold-water branches.
10. Electrical conduit branch feeders.
11. Fire sprinkler branch piping and sprinkler runouts.

B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2”).

C. Examine the contract documents of all trades (e.g. all Divisions 21 through 23 and 26 through 28 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).

D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.

E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.

F. Provide access doors for all equipment, valves, clean-outs, actuators and controls which require access for adjustment or servicing and which are located in otherwise inaccessible locations.

1. For equipment located in “accessible locations” such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. “Normal maintenance” includes, but is not limited to: filter changing; greasing of bearings; using p/t ports for pressure or temperature measurements; and replacement of ballasts, fuses, etc.

PART 2 - PRODUCTS

2.1 MOTOR HORSEPOWER

A. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general condition 2.1. A., above.

B. Work under Divisions 21 through 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Divisions 26 through 28, before ordering the equipment.

1. If motor horsepowers are changed under the work of Divisions 21 through 23 without a change in duty of the motor’s driven device, coordination of additional electrical work (if any) and additional payment for that work (if any) shall be provided under the section of Divisions 21 through 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect/Engineer.

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 23 05 01/26 05 01

SECTION 26 05 02 - BASIC MATERIAL AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1, General Requirements.

1.2 DESCRIPTION OF WORK

A. Work included in this section consists of conduits, wires and other miscellaneous materials not specifically mentioned in other sections of Division 26, 27 and 28 but necessary or required for equipment or system operation or function, and the labor to install them.

1.3 SUBMITTALS

A. Materials list with manufacturer, style, series or model identified.

B. Manufacturer’s descriptive literature and/or sample if requested by the Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Refer to Section 26 05 03.

2.2 CONDUIT RACEWAYS

A. Refer to Section 26 05 33.

2.3 ELECTRICAL POWER CONDUCTORS AND CABLES

A. Refer to Section 26 05 19.

2.4 WIRING DEVICES

A. Refer to Section 26 27 26.

2.5 OUTLET BOXES, JUNCTION AND PULL BOXES

A. Outlet Boxes: Hot-dipped galvanized or sherardized of required size, 4" square minimum, for flush-mounted devices and lighting fixtures. Cast-type FD with gasketed covers for surface-mounted devices.

B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from code-gauge sheet steel, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless-steel nuts, bolts, screws, and washers. Pull and junction boxes installed in finished spaces must be flush-mounted cabinets provided with trim, hinged door and flush latch and lock to match flush-mounted panelboard trim. Provide galvanized code-gauge steel where required for outdoor exposure.

C. All exterior boxes shall be in use gasketed, weatherproof type with cast metallic covers.

D. Refer to Section 26 05 33 for additional requirements.

2.6 WIRE CONNECTORS

A. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600-Volt, for building wiring and 1000-Volt in signs or fixtures.

B. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

2.7 CONDUIT HANGERS

A. Refer to Section 26 05 29 for additional requirements.

2.8 FUSES

A. Refer to Section 26 28 16.

2.9 ACCESS PANELS

A. Electrical Contractor to provide access panels for electrical equipment which are required for accessibility by code.

2.10 CONDUIT SLEEVES

A. Sleeves for Conduit Penetration: Hilti, Inc., model CP 6820-P; or 3M Corp. MCID or PCID. Refer to Division 7 "Firestopping" for additional requirements.

B. Exterior Wall Penetration Seals: Provide seals at all foundation of exterior wall locations. Link Seal or approved manufacturer.

2.11 EQUIPMENT MOUNTING AND SUPPORT HARDWARE

A. Steel channels, bolts and washers, used for mounting or support of electrical equipment shall be galvanized typed. Where installed in corrosive atmosphere, stainless-steel type hardware shall be used.

B. Refer to Section 26 05 29 for additional requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide complete raceway systems for all conductors including control wiring and low-voltage wiring unless otherwise noted.

B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.

D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.

E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.

3.2 RACEWAYS

A. Refer to Section 26 05 33.

3.3 OUTLETS

A. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and

will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.

B. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.

C. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds FS/FD or equal).

D. Dimensions unless shown on drawings are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of box)
Convenience outlets	1' - 4" (to bottom of box) – gyp or 8" block 1' – 6" (to bottom of box) – 6" block
Hallways	1' - 6" (to bottom of box)
Above counter wall outlet	0' - 8" (above counter to top of box, maximum 44" AFF, field verify height of backsplash)
Panelboards wall mounted	6' - 6" (to top of back box)
Wall phone outlet	4' - 0" (to top of box)
Tele/Data outlets	1' - 6" (to bottom of outlet)
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4' - 0" (to top of device)
Fire alarm strobes	6' - 8" or 6" below ceiling (whichever is lower)
Television outlets	Refer to A/V or architectural drawing.

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

E. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscoting, shall be at a height to prevent interference to service equipment, or as noted on drawings.

F. Refer to Section 26 05 33 for additional requirements.

3.4 JUNCTION PULL BOXES

A. Construct junction or pull boxes not over 150 cubic inches in size shall be standard outlet boxes, and those over 150 cubic inches shall be constructed the same as “Cabinets,” with screw covers of same gauge metal. Removal covers must be accessible at all times.

B. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.

END OF SECTION 26 05 02

SECTION 26 05 03 - MANUFACTURERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The following lists of manufacturers are for the specifications as identified.

B. All submittals and documentation shall be in accordance with the project General Requirements, Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed herein. All manufacturers not listed shall be pre-approved prior to bid in order to be considered. Refer to Division 1 for pre-approval format.

TITLE	SPECIFICATION SECTION	MANUFACTURER
Electrical Power Conductors and Cables	26 05 19	Aetna Insulated Wire Cerro Wire CME Wire and Cable Encore Wire Southwire Co.
Grounding and Bonding	26 05 26	ABB (Blackburn/Color-Keyed) nVent (Erico/Cadweld) Ideal Industries Hubbell (Burndy) VFC/Lyncole
Hangers and Supports - Slotted Metal Angle and U-channel Systems	26 05 29	ABB (Thomas and Betts Corp) Eaton (B-Line Systems) Atkore(Unistrut Diversified Products)
- Conduit Sealing Bushings	26 05 29	ABB(Thomas and Betts Corp.) Emerson (OZ/Gedney) Hubbell (RACO)

TITLE	SPECIFICATION SECTION	MANUFACTURER
Raceways		
- Conduit and Tubing	26 05 33	ABB(T&B - OCAL) Atkore (Allied Tube & Conduit) Carlon, Inc. JM Eagle Rob Roy Industries Wheatland
- Conduit Bodies	26 05 33	ABB(Thomas and Betts Corp.) Emerson (Appleton Electric) Eaton (Crouse-Hinds) Hubbell (Killark Electric)
Wireway and Enclosures	26 05 33	Eaton (Cooper B-Line) nVent (Hoffman) Hammond Mfg.
Surface Raceways	26 05 33	Hubbell Legrand (Wiremold)
Electrical Boxes and Fittings		
Raintight outlet boxes	26 05 33	ABB (T&B – Red Dot) Emerson (Appleton Electric) Eaton (Crouse – Hinds) Hubbell (RACO)
Bushings, knockout closures and locknuts	26 05 33	ABB (T&B – Steel City) Emerson (Appleton Electric) Eaton (Crouse – Hinds) Hubbell (RACO)
Identification	26 05 53	Ideal Industries, Inc. Panduit Corp. Seton Identification Product. Brady, Co.
Low-Voltage Distribution Transformers	26 22 13	Eaton ABB (GE) Siemens Schneider Electric (Square D)

TITLE	SPECIFICATION SECTION	MANUFACTURER
Switchboards Panelboards	26 24 13 26 24 16	Eaton ABB (GE) Siemens Schneider Electric (Square D)
Wiring Devices		
- Receptacles and Switches	26 27 26	Eaton (Cooper) Hubbell, Inc. Leviton Legrand (Pass & Seymour)
- Dimmers	26 27 26	Lutron Phillips
- Occupancy Sensors	26 27 26	Lutron Legrand (Wattstopper) Hubbell Sensorswitch
Connections	26 28 16	ABB(Thomas and Betts Corp.) Emerson (Appleton Electric) Hubbel (Burndy Corp.) Ideal Industries, Inc.
Fuses (See Note)	26 28 16	Eaton (Bussman) Mersen (Ferraz Shawmut) Littelfuse
Gas-Engine Driven Generator Sets	26 32 14	Caterpillar Tractor Co. Kohler Co. Cummins Generac MTU
Automatic Transfer Switches	26 36 23	Automatic Switch Company Caterpillar Kohler Co. Cummins MTU Generac Russ Electric, Inc. GE (Zenith)
NOTE: Contractor shall submit fuse coordination for the entire electrical distribution if alternate manufacturer is used.		

PART 3 - EXECUTION - NOT USED.

END OF SECTION 26 05 03

SECTION 26 05 05 - ELECTRICAL DEMOLITION AND RELOCATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section supplements Division 1, General Requirements. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. The Architect shall decide which is more stringent.

B. Requirements of the following Divisions and Sections apply to this Section:

1. Division 26 Section 26 05 00 “Electrical Requirements.”
2. Division 9 Section “Painting” for related requirements.

C. Refer to other Division 26 Sections for additional specific electrical demolition or relocation associated with specific items.

1.2 SUMMARY

A. This Section includes basic requirements for demolition and relocation of electrical materials, equipment, and installations. The Contractor shall be responsible for visiting the site prior to bid to determine the actual conditions, which might affect the bid or contract price. No allowance will be made subsequently resulting from the neglect to visit the site and make such determinations.

B. Generally, electrical items that are to be replaced with other equipment in the same location are work covered by this section. Also covered by this section are electrical items that are to be removed in their entirety or that are to be relocated to another place.

1.3 UTILITY SERVICES

A. Maintain existing utility services. Where necessary to cut existing conduits, wires, cables, etc. of utility services or fire protection systems, they shall be cut and capped at suitable places or where directed by the Owner’s representative.

B. Electrical service in demolition area shall be reduced to a minimum and identified to eliminate uncertainty about which circuits are energized.

C. The Contractor shall notify the Owner’s representative in writing of any planned utility interruptions including interruptions of power to communications and fire protection systems at least 48 hours in advance or as otherwise specified. The request shall state the reason, date, beginning time, and expected duration of such interruptions. No interruptions shall be made

without the Owner's written concurrence and such interruptions shall be coordinated with the Owner to cause the least inconvenience to the Owner's operations. Service interruptions which cannot wait for written approval may be granted with verbal approval from the Owner's representative. After verbal approval is granted, written confirmation shall be issued by the Contractor as soon as practical.

1.4 PROTECTIVE MEASURES

A. Provide the following protective measures:

1. Wherever existing roofing surfaces are penetrated by electrical conduit, they shall be protected against water infiltration. Water leaks shall be repaired immediately upon discovery when they occur.
2. Temporary protection against damage for all portions of existing structures and grounds where work is to be done, materials handled, and equipment moved or relocated.
3. Contractor shall patch and fill openings in floors, walls and ceilings for removed equipment or piping with the same material, fire and structural integrity that would have existed prior to the penetration including concrete, block, gyp wallboard, exterior walls, roof membranes, etc. except for steel and wood beams which shall have the openings capped with similar material.

B. The Contractor shall be responsible for contacting utilities or locating services and obtaining locations of all underground services in the general area of demolition work.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. The Contractor shall provide all equipment and materials necessary for the removal or relocation of electrical equipment.

B. Materials used in restoration or repairing work related to demolition and relocation shall conform in type, quality, and function to that of the original existing construction or as otherwise indicated.

2.2 DISPOSAL AND RETENTION

A. Materials and equipment resulting from work and removed from the building or structures, or parts thereof, shall become the property of the Contractor and shall be removed from the site by the Contractor except as follow:

1. Light fixtures, lamps, and ballasts.
2. Fire, heat, and smoke detection devices.
3. Telephones and telephone equipment other than outlet devices.

4. Fire alarm notification devices and pull stations.
5. Paging speakers, clocks, and intercom call stations.

B. Items removed or noted to be retained by the Owner but which are declined to be retained by the Owner shall be removed from the site by the Contractor.

C. Combustible waste material and rubbish shall not be stored or allowed to accumulate within a building or its vicinity, but shall be kept in a suitable trash container for subsequent removal or shall be removed from the premises as rapidly as practical.

D. All hazard waste shall be properly disposed of by a licensed hazard waste disposal facility. Items shall include but not limited to fluorescent lamps, diesel fuel, radiator coolant, etc.

PART 3 - EXECUTION

A. Remove or relocate all items indicated on the drawings or as otherwise indicated.

B. Where the drawings indicate that equipment is to be replaced or where other equipment requires the relocation of existing equipment, the existing equipment shall be removed or relocated as though it was specifically noted to be removed or relocated.

C. Wherever electrical materials have been removed from surfaces of the building or structure, those surfaces shall be patched and repaired.

D. Remove, cut, alter, replace, patch, and repair existing work as necessary to install new work. Unless otherwise indicated or specified, do not cut, alter, or remove any structural members, ducts, piping, or service lines without approval of the Owner's representative.

E. Existing work or equipment to be altered or extended and found to be defective shall be reported to the Owner's representative before it is disturbed or any further work is performed on it.

F. Where electrical equipment is indicated to be removed or relocated, the work shall include the complete disconnection from its source, dismantling as necessary, and removal or installation of all conduit, wires, cables, etc. Unless noted otherwise, wires shall be removed from conduits back to the last utilization device or to the panelboard. No wiring shall be removed that prevents operation of other equipment not scheduled or indicated to be removed.

G. Perform and schedule all demolition work with other trades and work of the contract as necessary for the efficient progress and flow of the work.

END OF SECTION 26 05 05

SECTION 26 05 10 - TESTING

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Acceptance and startup testing requirements for electrical power distribution equipment and systems. Contractor shall retain and pay for the services of a recognized independent testing firm for purpose of performing inspections and tests as herein specified.

1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
2. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
3. The tests and inspections shall determine suitability for startup and energization.
4. The following equipment shall be tested and calibrated:

   Grounding and Bonding – Section 26 05 26
   Low-Voltage Distribution Transformers – Section 26 22 13
   Panelboards – Section 26 24 16
   Automatic Transfer Switch – Section 26 36 23
   Gas-Engine Driven Generator Set – Section 26 32 14

1.2 SUBMITTALS

A. Provide submittal per Contract General Conditions, Division 1, and Section 26 05 00.

B. Qualification of testing firm.

C. Submit one electronic copy of certified test reports to Engineer for approval.

D. One electronic copy of blank forms for checklists, test reports, and other related forms for Engineer's review and approval.

1.3 GENERAL REQUIREMENTS

A. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to any acceptance testing.

B. The Contractor shall test all lighting, low-voltage relays and circuits to ensure proper operating conditions prior to acceptance testing.

C. The Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.

D. The Contractor shall be responsible for all final settings and adjustments on protective devices and tap changes, submitting settings to the Architect/Engineer for review.

E. Provide a complete short-circuit study, equipment interrupting/withstand evaluation, and a protective device coordination study for the electrical distribution system described herein. This study shall be submitted with electrical equipment submission and electrical room layouts.

F. The Contractor shall engage the services of a recognized corporate and financially independent testing firm for the purpose of performing inspections and tests as herein specified.

G. The firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

H. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

I. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.

1.4 QUALIFICATIONS OF TESTING FIRM

A. The testing firm shall be a recognized corporate and financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association (NETA).

D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.

E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing and engineering services. All studies, tests, and reports shall be sealed by a registered electrical professional engineer with a current Colorado stamp.

F. The testing firm shall submit proof of the above qualifications with bid documents, when requested.

G. The terms used herewith, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

1.5 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:

1. National Electrical Manufacturer's Association - NEMA
2. American Society for Testing and Materials - ASTM
3. Institute of Electrical and Electronic Engineers - IEEE
4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-2009
5. American National Standards Institute - ANSI C2: National Electrical Safety Code
6. State and City of Steamboat Spring, CO Codes and Ordinances
7. Insulated Cable Engineers Association - ICEA
8. Association of Edison Illuminating Companies - AEIC
9. Occupational Safety and Health Administration - OSHA
10. National Fire Protection Association - NFPA

    a. ANSI/NFPA 70: National Electrical Code
    b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    d. ANSI/NFPA 780: Lightning Protection Code
    e. ANSI/NFPA 101: Life Safety Code

B. All inspections and tests shall utilize the following references:

1. Project design specifications.
2. Project design drawings.
3. Short-circuit and coordination study.
4. Manufacturer's instruction manuals applicable to each particular apparatus.
5. Project list of equipment to be inspected and tested as stated above.

PART 2 - SHORT-CIRCUIT, COORDINATION, AND ARC FLASH STUDIES

2.1 SHORT-CIRCUIT STUDY

The electrical equipment manufacturer shall perform a short-circuit analysis of the specified electrical power distribution system. This analysis shall include:

A. Calculation of the maximum RMS symmetrical three-phase short-circuit current available at significant locations in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short-circuit currents shall be calculated with the aid of a digital computer. Appropriate motor short-circuit contribution shall be included in the calculation.

B. The study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.

C. The study shall be calculated from the utility meter to the unit substation to the lowest overcurrent device or equipment on the electrical distribution system. The utility conductors shall not be used for calculations.

D. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer.

E. Provide one electronic copy of the short-circuit analysis for the engineer’s approval.

F. A computer printout of input data, a computer printout of calculated results and an explanation of how to interpret the printouts.

G. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.

H. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X/R ratio of the fault current.

I. A table of equipment short-circuit ratings versus calculated short-circuit current values.

J. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner, where approved by the Engineer.

2.2 ARC FLASH HAZARD ANALYSIS

A. Provide with the coordination and short circuit studies an Arc Flash study and device by device listing of PPE requirements and ratings as required by the NEC and NFPA 70E. All equipment shall have appropriate labeling installed in the field by the electrical contractor as determined by the study.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchgear, switchboards, panelboards, busway, etc.) where work could be performed on energized parts.

PART 3 - INSPECTION AND TEST PROCEDURES

3.1 PROCEDURE

A. Testing firm to provide and comply with the following:

1. Acceptance test procedures for each individual equipment listed in Part 1 of this section for Engineer review and approval prior to any test and after thorough evaluation of the system. Testing shall conform to the latest version of InterNational Electrical Testing Association (NETA) specifications and standards for electrical power distribution equipment and systems and manufacturer's instructions.
2. Refer to each individual specification section for testing requirements and comply.
3. Inspect installed equipment, record results and report any discrepancy and deficiency with contract documents and governing codes prior to testing. All results shall be submitted to the Engineer for approval.

3.2 SYSTEM FUNCTION TESTS

A. General:

1. Perform system function tests upon completion of equipment component tests as define in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
2. Implementation:

    a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
    b. Test all interlock devices, and trip settings on breakers.
    c. Record the operation of alarms and indicating devices.

3.3 DEFICIENCIES

A. All deficiencies reported by testing firm to be corrected by Contractor and Acceptance Test to be re-done accordingly.

END OF SECTION 26 05 10

SECTION 26 05 19 - ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirement of the following Division 26 Sections apply to this section:

1. Electrical Requirements

1.2 SUMMARY

A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600-Volts and less.

B. Related Sections: The following Sections contain requirements that relate to this section:

1. Division 31 Section “Earthwork” for trenching and backfilling.
2. Division 26 Section “Electrical Boxes and Fittings” for connectors for terminating cables in boxes and other electrical enclosures.
3. Division 26 Section “Raceways and Boxes” for MC cable, raceway and boxes.

1.3 SUBMITTALS

A. Product Data for electrical wires, cables and connectors.

B. Submit pulling tension calculations for all underground feeders.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following code:

B. NFPA 70 “National Electrical Code.”

1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

C. UL Compliance: Provide components, which are listed and labeled by UL under the following standards.

1.	UL Standard 44	Rubber Insulated Wires and Cables
2.	UL Standard 83	Thermoplastic-Insulated Wires and Cables
3.	UL Standard 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors
4.	UL Standard 854	Service Entrance Cable
5.	UL Standard 2196	Testing for Fire Resistive Cables
6.	UL Standard 1424	Cables for Power-Limited Fire-Alarm Circuits

D. NEMA/ICEA Compliance: Provide components which comply with the following standards:

1. WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. WC-7: Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

E. IEEE Compliance: Provide components, which comply with the following standard.

1. Standard 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

PART 2 - PRODUCTS

2.1 WIRES AND CABLES (600-VOLT COPPER CONDUCTORS – BASE DESIGN)

A. General: Provide suitable wire and cable for the temperature, conditions and location where installed. All wires and cables shall be new and delivered to the site in unbroken packages and reels.

B. All wires and cables shall be of the same manufacturer throughout the entire project.

C. Conductors: Provide solid conductors for power and lighting circuits #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.

D. Conductor Material: All wires and cables shall be copper, single conductor rated at 600-Volts, which conform to or exceed ICEA specifications and the following:

1. In sizes 1/0 AWG to 4/0: Cross-linked polyethylene insulation type XHHW-2 (90°C) or THWN-2.
2. In sizes 250 KCMIL and larger: Type XHHW-2 (90°C) or THWN.

3. In sizes 1 AWG and smaller: All conductors shall have heat/moisture resistant thermoplastic insulation type THWN-2 (90°C) except as follows:

    a. Where conduit temperature will exceed 100°F, use type THHN (90°C).
    b. In 120-Volt incandescent fixtures, type SF-2 or SFF-2 (150 - 200°C).
    c. In wireway of fluorescent lighting fixtures type THHN (90°C).

E. Rated Conductor Material: Where required by these specifications and code, provide 2-hour rated cable conforming to the following requirements:

1. Cabling must meet current UL requirements for fire alarm resistance.
2. Cabling must meet current NEC 517, 700 and 760 requirements.

F. Grounding conductors: Shall be of the same type as its associated phase conductors.

G. All conductors shall be label with wire size, insulation rating, etc. using an engraved process, computer scan on labels are not permitted.

H. Color Coding for phase identification in accordance with Table 1 in Part 3 herein.

I. Connectors for Conductors:

1. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
2. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600-Volt, for building wiring and 1000-Volt in signs or fixtures.
3. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

J. Splices and Taps:

1. No. 10 AWG and smaller - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600-Volt, 105°C with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.
2. No. 8 AWG and larger - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90-degree, 600-Volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage, and temperature and shall not have an insulation value less than the conductors being joined.

2.2 ALUMINUM WIRES AND CABLES (ALTERNATE DESIGN)

A. Where indicated on drawings as AL: aluminum alloy, compact stranded, Type XHHW-2 or THHN/THWN, 90°C meeting requirements of UL#44 and Federal Spec A-A-59544 with XLPE insulation and AA-8000 series alloy only may be used in lieu of copper conductors.

B. Terminations shall be compression bolted lug with appropriate joint compounds and Belleville spring washers.

C. Installation and terminations shall be in strict accordance with manufacturer's recommendations and as identified in specifications.

D. Uses not allowed:

1. If not specifically shown on drawings with AL identifier.
2. For service-entrance conductors where Utility Company standards prohibit aluminum conductors
3. For any feeders or branch circuits to mechanical and vibrating equipment.
4. For any applications under 200Amps.
5. Where terminations that are unable to utilize compression, bolted lug fittings.
6. For use as emergency and standby system feeders or branch circuits.

E. All grounding conductors shall be copper.

F. Refer to feeder table on drawings for conductor and conduit sizes to correspond with over current protection device size.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Use the following wiring methods as indicated:

1. Install all wire in raceway. Power and control wiring shall be installed in separate raceways.

3.2 INSTALLATION OF WIRES AND CABLES

A. General: Install electrical cables, wires, and connectors in compliance with NEC.

B. Coordinate cable and wire installation with other Work.

C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three ungrounded conductors are to be installed in any one conduit on a 3-phase, 4-wire system, unless specifically noted otherwise on the drawings. When more than three ungrounded

conductors are installed in a raceway, the conductor size shall be increase per code for derating. No two ungrounded conductors of the same phase are to be installed in the same conduit, unless specifically noted otherwise on the drawings.

1. Where multi-wire circuits are permitted by these specifications, all grounded and ungrounded conductors shall be grouped by wire markers, cable ties or similar means with the panelboard or wireway at least one location.

D. Provide dedicated neutral conductor for all single phase circuits. Shared neutral conductor is not acceptable on single phase circuits.

E. Minimum wire size shall be a No.12 AWG except for control or signal circuits, which may be No. 14 AWG.

F. Unless otherwise indicated on drawings, all wiring for branch circuits shall be a minimum No. 12 AWG in ¾" conduit, protected by 20 amperes circuit breakers. If distance from panel to first outlet is 75 feet or greater for 120-Volt circuits, and 125 feet or greater for 277-Volt circuits, No. 10 AWG shall be installed throughout the circuit, unless noted otherwise on the drawings.

G. Size of current carrying conductors, unless noted otherwise on drawings, shall be determined from Table 310.15(B)(16) of the latest National Electric Code for the load served.

H. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

I. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

J. Size of conduits, unless specifically shown, shall be determined from Appendix C of the latest National Electrical Code.

K. Keep conductor splices to a minimum. All splices shall be made within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code.

1. Splices shall not be permitted within 25 feet of any panel or electrical room.
2. Do not splice conductors in panelboards, safety switches, switchboards, motor control centers or motor control enclosures.
3. Splices in conductors installed below grade will not be permitted, unless approved in writing by the Architect and Engineer.

L. Install splice and tap connectors, which possess equivalent or better mechanical strength and insulation rather than conductors being spliced.

M. Use splice and tap connectors which are compatible with conductor material.

N. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

O. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers' torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque values specified in UL 486A and UL 486B. After tightening the connection/terminal, mark the bolt surface and that of the product or workpiece. Then loosen the bolt. Re-tighten it until the markings re-align. The torque needed to return the bolt to its original position is the torque value of the bolt.

3.3 FIELD QUALITY CONTROL

A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.

B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.

C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

D. Prior to completion of project, an infrared scan of switchgear and panelboard feeder equipment connection shall be performed when all loads are energized.

E. TABLE I: Color Coding for Phase Identification:

1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

208V/120-Volts	Phase	480V/277-Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

3.4 FEEDER TESTING

A. Products

1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the test described in this section.

B. Execution

1. Visual and Mechanical Inspection

   a. Inspect cables for physical damage and proper connection in accordance with one-line diagrams.
   b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
   c. Check cable color coding with specification section 26 05 53 and National Electrical Code standards.

2. Electrical Tests

   a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000-Volts D.C. for 1 minute.
   b. Perform continuity test to insure proper cable connection.

3. Test Values

   a. Evaluate results by comparison with cables of same length and type. Investigate any insulation-resistance values less than 50 megohms.
   b. Submit results to Engineer for approval in accordance with Section 26 05 10.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26 Basic Materials and Methods sections apply to work of this section.

C. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

1.2 SUMMARY

A. Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Type of electrical grounding and bonding work specified in this section includes the following:

1. Solidly grounded.

C. Applications of electrical grounding and bonding work in this section includes the following:

1. Underground metal piping.
2. Underground metal water piping.
3. Underground metal structures.
4. Building frames - structural steel.
5. Electrical power systems.
6. Grounding electrodes.
7. Separately derived systems.
8. Raceways.
9. Enclosures.
10. Equipment.

D. Refer to other Division 26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

B. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

C. Submit ground riser diagram for entire project. Show bus bars with transformer ground electrode conductors, etc.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with electrical grounding work similar to that required for project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
2. ANSI Compliance: C119.4 Electrical Connectors,
3. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Standard 486A-486B, "Wire Connectors and soldering Lugs for Use with Copper Conductors." UL Standard 486C "Splicing Wire Connectors" UL1059 "Terminal Blocks. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
4. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
5. NFPA Compliance: NFPA 70 National Electrical Code, NFPA 780" Standard for the Installation of Lightning Protection Systems"

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and Components:

1. Provide electrical grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductors, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductors.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper 1/4 by 3 by 12 inches (6 by 76 by 300 mm) in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Mechanical Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts. Of type recommended by ABB (Blackburn/Color-Keyed) Installation Products, (Burndy) Hubbell Inc or equal.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Irreversible Compression Connectors: Use for connections to structural steel and for underground connections except those at test well. Install connection to ground rods. Comply with manufacturer's written recommendations and training. Must be factory filled with an oxide inhibitor and installed with manufacturers recommend dies. The die index must match the listed index for the connector. Use of a 14 Ton or larger hydraulic compression tool to provide correct circumferential pressure for compression connectors and index die numbers are properly indented. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code method to make visible indication that the connector has been adequately compressed on the ground conductor, ground rod or ground plate. Irreversible compression connectors may be used below grade, above grade and concrete incased applications. Of types recommended by ABB (Blackburn) Installation Products, Burndy (Hubbell Inc). or approved equal.

D. Welded Connectors: Exothermic-welding kits of types recommended by ABB (Furseweld) Installation Products, Burndy (Thermoweld) Hubbell Inc. Erico – nVent (Cadweld) (or approved equal) manufacturer for materials being joined and installation conditions. Exothermically welded connections are required on all grounding electrode conductors other than water pipes, all connections to building steel (connections to structural member), all grounding conductors run under the earth, connection to ground rods and in any case where grounding conductors are subject to a hostile environment.

1. The exothermic welding system furnished under these specifications shall meet the applicable requirements of IEEE80, Chapter 9, Section of conductors and joints.
2. Molds shall be made from graphite or other material that is so designed to provide an average life of not less than 50 exothermic welds under normal conditions. 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. Instructions detailing general safety information, and welding procedures shall be provided with each mold.
3. Starting material, if used, shall consist of aluminum and copper/copper oxide and iron oxides. It shall not contain phosphorous or any caustic, toxic or explosive substance. Weld metal used for grounding connections shall contain copper oxide, aluminum. Where welding is done in enclosed structures, the Erico Exolon smokeless system shall be used.

E. Exothermic connections are to be performed by manufacturer's trained personnel with a qualification and/or training certificate on file with the contractor.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-bonded steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No.10 AWG and smaller, and stranded conductors for No.8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned copper conductor, No.3/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade. In areas subject to long term and deeper freezing a lower depth may be in order.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
3. Copper Ground Loop: Bury a minimum of 30” below grade.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. The conduit shall not be acceptable as an equipment ground.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Protection:

1. All grounding electrode conductors smaller than #6 AWG shall be routed in conduit – EMT or Rigid/IMC if exposed to damage or weather.
2. All grounding electrode conductors #6 AWG and larger shall be routed in conduit – EMT or Rigid/IMC if exposed to weather.

D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.3 EXAMINATION

A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.4 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

A. General: Install electrical grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods, spaced at least one-rod length from an adjacent grounding means (such as Ufer, building steel or cold water pipe).AND/OR two-rod lengths from an adjacent rod (i.e. 16’ apart for 8’ rods & 20’ apart for 10’ rods), and connect to the service grounding electrode conductor.

E. Test Wells: Provide test wells as required by the NEC.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

F. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment
3. Use exothermic-welded connectors or irreversible compression connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

G. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, each unit substation, or each main electrical room grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

H. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

I. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

J. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

K. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

L. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.5 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 26 Sections apply to this section:

1. "Electrical Requirements."

1.2 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Related Sections: The following Sections contain requirements that related to this Section:

1. Division 3 Section "Mild Steel Concrete Reinforcement" for inserts, anchors, and sleeves to be installed in concrete for use with supporting devices.
2. Division 5 Section "Metal Fabrications" for requirements for miscellaneous metal items involved in supports and fastenings.
3. Division 7 Section "Firestopping" for requirements for firestopping at sleeves through walls and floors that are fire barriers.
4. Refer to Division 26 Sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified.

1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

C. Shop drawings indicating details of fabricated products and materials.

D. Engineered Design consisting of details and engineering analysis for supports for the following items:

1. Conduit (racked)
2. Ceiling-mounted boxes, transformers.
3. Conduit - Ceiling mounted, concrete encased.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code.”

B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

C. Installation shall comply with local authorities seismic requirements.

PART 2 - PRODUCTS

2.1 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized and where installed in corrosive atmosphere, stainless-steel type channel and hardware shall be used.

2.2 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads. Aircraft cable and other non-rigid supports shall not be permitted for use as supporting material for conduit.

C. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.

D. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls.

Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

E. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

F. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.3 FABRICATED SUPPORTING DEVICES

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer’s recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers. All supporting rods shall be rigid. Aircraft cable and other similar non-rigid cable shall not be used to support horizontal conduit.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 1/2 inch and smaller raceways serving lighting

and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼-inch diameter or larger threaded steel. Use spring fasteners that are specifically designed for supporting single conduits or tubing.

6. Space supports for raceway in accordance with NEC.
7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, supports at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples of threadless box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors (i.e., strain reliefs).

1. Support shall be at each individual conductor.

E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and wall for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with “Fire Stopping” requirement of Division 7.

H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions or light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

J. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.

K. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 26 Sections apply to this Section:

1. "Electrical Requirements."
2. "Basic Material and Methods"

1.2 SUMMARY

A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.

B. Provide complete raceway systems for all conductors including control wiring and low-voltage wiring unless otherwise noted.

C. This Section includes raceways for electrical wiring. Types of raceways, boxes and fittings in this section include the following:

1. Electrical metallic tubing (EMT).
2. Flexible metal conduit.
3. Intermediate metal conduit (IMC).
4. Liquid-tight flexible conduit.
5. Rigid metallic conduit (RMC).
6. Metal clad cable (MC).
7. Surface raceways.
8. Rigid non-metallic conduit.
9. Electrical non-metallic tubing (ENT)
10. Wireway.
11. Outlet boxes.
12. Junction boxes.
13. Pull boxes.
14. Bushings.
15. Locknuts.
16. Knockout closures.

D. Related Sections: The following section contains requirements that relate to this section:

1. Division 26 Section “Raceway and Boxes” for conduit connectors, fittings, and couplings.
2. Division 7 Section “Firestopping” for conduit penetrations through rated walls and slabs.

E. Section only applies for electrical systems to be installed within raceways. This excludes beverage piping and pneumatic systems pulled within raceways.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of contract and Division 1 Specification Section.

B. Product Data for the following products:

1. Raceways and fittings.
2. Wireways and fittings.
3. Boxes and fittings.

C. Installation Instructions: Manufacturer’s written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code.”

B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL.

D. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five years.

E. Installer’s Qualifications: Firms with at least five years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.

F. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

G. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.

H. NEMA Compliance: Comply with applicable requirements of NEMA Standards/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.

I. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1

B. PVC Coated Rigid Galvanized Steel Conduit: ANSI C80.1, UL6 & NEMA RN-1 2018

C. Intermediate Steel Conduit: UL 1242.

D. Electrical Metallic Tubing and Fittings: ANSI C80.3.

E. Flexible Metal Conduit: UL 1, zinc-coated steel.

F. Liquid-tight Flexible Metal Conduit and Fittings: UL 360.

2.2 METAL CLAD CABLE, TYPE MC

A. The multi-conductor metal clad cable shall comply with UL 1569 "Metal Clad, Type MC," UL 83 "Thermoplastic Insulated Wires and Cables" Federal Specification J-C-30B "Wire and Cable," Local and National Electrical Codes.

B. The metal clad cable shall be THHN insulation, copper conductors in sizes #12 through #8 AWG only for continuous operation at a maximum conductor temperature of 90 degree C dry.

C. These cables shall bear appropriate Underwriters Laboratories labels for metal clad cable and be suitable for use as branch circuits in both exposed and concealed work in accordance with applicable sections of the National Electrical Code.

D. An insulated grounding conductor sized in accordance with Table 5.3 Underwriter's Standard UL 1569 shall be cabled with the circuit conductors and shall be identified in compliance with Section 29 of UL 1569. The grounding conductor shall not be smaller than size indicated in NEC Article Table 250.122.

E. A galvanized steel or aluminum armor shall be applied over the inner cable assembly with a positive interlock in compliance with Section 10 of UL 1569. MC cable with a PVC jacket shall not be permitted to be installed in slabs.

2.3 CONDUIT BODIES AND FITTINGS

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.

C. EMT Conduit Bodies 1 Inch and Smaller: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.

D. EMT Conduit Bodies 1 Inch and Larger: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.

E. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL514B.

F. PVC Coated RGS Conduit Bodies: Conduit bodies shall have a nominal 40mils of PVC and 2mils of interior urethane and shall be NEMA 4X listed with encapsulated stainless-steel screws.

G. Liquid-Tight Flexible Conduit Fittings: With threaded grounding cone, steel, nylon or equal plastic compression ring, and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without O-ring seal. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.

H. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit, IMC and EMT, larger than 3/4” size.

I. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring and internal bonding jumper. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25’ or less, and the long type in runs 26’ to 80’. The long type shall be a two piece barrel and piston joint, providing 6” of the total movement range in 3/4” through 6” conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2” of total movement range in 3/4” to 2” conduit sizes.

J. Seal Off Fittings: Refer to section 26 05 02 for additional requirements.

K. Sleeves for Conduit Penetration: Refer to section 26 05 02 for additional requirements.

2.4 WIREWAYS

A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.

B. Wireway covers shall be hinged type.

2.5 SURFACE RACEWAYS

A. General: Sizes and channels as indicated on drawings. Provide fittings that match and mate with raceway. Provide internal barriers for areas with power and communications sections.

B. Surface Metal Raceway: Construct of two piece galvanized steel with snap-on covers, with 9/32-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required. Sizes 1-3/4" H x 4-3/4" W.

C. Accessories:

1. Couplings for joining raceway sections.
2. Wire clips for conductors.
3. Blank end fittings.
4. Circuit breaker housings for single pole breakers.
5. Device brackets for single or two gang devices.
6. Combination receptacle and tele/data outlet covers.
7. Outlet boxes with hubs for conduit connectors.

2.6 FABRICATED MATERIALS - BOXES

A. Outlet Boxes: Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes (minimum 4-inch square, 1 ½-inch deep), including box depths as required, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

1. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension

rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.

B. Device Boxes: Provide galvanized coated flat rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes (minimum 4-inch square, 1 ½-inches deep), including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with conduit-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide conduit connectors and corrosion-resistant screws for equipment type grounding.

1. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster ears, and plasterboard expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.

C. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.

D. Junction and Pull Boxes: Provide code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless-steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush-mounted cabinets provided with trim, hinged door and flush latch and lock to match flush-mounted panelboard trim. Provide galvanized code-gauge steel where required for outdoor exposure.

E. Exterior junction or pull boxes, flush with grade:

1. All exterior pull box locations shall be submitted and approved by landscape architect prior to installation.
2. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Box dimensions shall be 30"W x 48"L x 36"D. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless-steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.

F. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Outdoors: Use the following wiring methods:

1. Exposed: Intermediate metal conduit, rigid steel conduit, raintight box.
2. Concealed: Intermediate metal conduit, rigid steel conduit.
3. Underground, Single Run: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
4. Underground, Grouped: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.

B. Indoors: Use the following wiring methods:

1. Exposed (below 10 ft. to floor): Intermediate metal conduit, rigid steel conduit.
2. Exposed (above 10ft. or in electrical room): Electrical metallic tubing.
3. Concealed: Electrical metallic tubing.
4. Concealed: Metal clad cable will be allowed as final branch wiring of receptacles (maximum total length of 25’ from homerun J-box or hard piped J-box to first outlet on circuit). MC is not allowed for homeruns to panels, connections to mechanical equipment. Maximum conductor size is in MC cable #8 AWG. MC is acceptable for final light fixture connection, maximum 6’ length.
5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Flexible metal conduit.
6. Connection to Vibrating Equipment in Moist/Humid or Corrosive Atmosphere including pneumatic or electric solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.
7. Within concrete slabs: Rigid non-metallic conduit. PVC coated MC cable and ENT is not allowed. Homeruns shall be in conduit. Maximum sizes and locations as approved by the Structural Engineer.
8. Raceway mounted to underside of metal-corrugated sheet roof decking shall be Rigid Metal Conduit or intermediate Metal Conduit.
9. Exposed Wet Locations: Intermediate metal conduit, rigid steel conduit, raintight box.
    a. Provide conduit bodies or exterior boxes with a minimum of 1/8” drain. Drain shall be located to allow exterior raceway system to drain.
10. Corrosive Environment, including areas where pool equipment is installed or areas where chemicals are stored: Rigid Metal Conduit, intermediate Metal Conduit, PVC fiberglass.

3.2 INSTALLATION OF RACEWAYS

A. General: Install electrical raceways in accordance with manufacturers’ written installation instructions, applicable requirements of NEC, and as follows.

B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.

D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.

E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.

F. Minimum size conduit shall be 3/4” for power circuits and 1” for telecommunications devices.

G. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

H. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.

I. Complete installation of electrical raceways before starting installation of conductors within raceways.

J. Provide supports for raceways as specified elsewhere in Division 26 and in accordance with NEC and local authorities’ seismic requirements.

K. Prevent foreign matter from entering raceways by using temporary closure protection.

L. PVC coated rigid galvanized steel conduit systems: Provide onsite installation training course by company representative. The representative shall conduct onsite training course to qualify for the installation certificate. After the onsite training installation, the representative shall then register the installer in his data base and provide certification for installation.

M. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells. Where elbows end below the slab, extend PVC coated rigid conduit a minimum of 6 inches above the finished slab.

N. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

O. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.

P. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.

Q. Raceways embedded in slabs shall only be permitted with the strict written approval of the Structural Engineer and Architect. For bidding purpose, conduit shall not be permitted in slab.

R. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.

S. All exposed conduits in public areas shall be painted to match surrounding walls. Verify exact color with the Architect. Coordinate painting of all exposed conduits with Construction Manager / General Contractor.

T. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways are of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.

U. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.

V. Tighten set screws of threadless fittings with suitable tool.

W. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.

X. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

Y. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.

Z. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Fitting should come complete with O-ring gasket. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
2. Where required by the NEC.

AA. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.

BB. Flexible connection: Use length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate equipment grounding conductor across flexible connections.

CC. Install nonferrous conduit or tubing for circuits operating above 60 Hz.

DD. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

EE. All underground conduits shall be installed a minimum of 48 inches below finish grade for medium-voltage feeders and 30 inches for 480-Volt feeders. All other conduits shall be installed in accordance with the NEC and coordinated depth with other trades.

FF. Grounding: Install a separate green equipment grounding conductor in all raceways from the panelboard/junction box supplying the raceway to the receptacle or equipment ground terminals. Conduits will not be permitted as a ground conductor.

GG. Clearances: All electrical raceways shall be routed to maintain appropriate clearances from low-voltage raceways per NEC, ANSI/EIA/TIA, and BICSI requirements. Provided below are minimum requirements of key components that shall be maintained. For any instances where field conditions do not allow for the minimum clearances, the Contractor shall notify the Architect and Engineer so that an acceptable solution can be coordinated.

1. 120V Power Conduits: 6 inches (150mm)
2. 208V and Higher Power: 24 inches (600mm)
3. Lighting System: 12 inches (300mm)
4. Transformers: 48 inches (1200mm)
5. Motors and Fans: 48 inches (1200mm)

6. Other Interfering Sources to be field verified and coordinated by Contractor with Architect and Engineer.

HH. Support: All electrical raceways shall be independently supported. Support from suspended ceiling elements is not permitted.

3.3 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Dimensions unless shown on drawings are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of box)
Convenience outlets	1' - 4" (to bottom of box) – gyp or 8" block
	1' – 6" (to bottom of box) – 6" block
Panelboards wall mounted	6' - 6" (to top of back box)
Wall phone outlet	4' - 0" (to top of box)
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4' - 0" (to top of device)
Fire alarm strobes	6' - 8" or 6" below ceiling (whichever is lower)

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

C. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.

D. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

E. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted.

F. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.

G. Provide outlets in rain tight box with metallic "in use" covers for interior and exterior locations exposed to weather or moisture.

H. Provide rain tight box for all interior, exterior and non-conditioned locations exposed to weather or moisture. This includes boxes located under overhangs not directly exposed to moisture.

I. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds FS/FD or equal).

J. Provide knockout closures to cap unused knockout holes where blanks have been removed.

K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

L. Electrical Contractor to provide access panels for electrical boxes which are code required to have accessibility.

M. Installing boxes back-to-back in walls shall not be permitted. Provide no less than 12 inches (150 mm) of separation.

N. Position recessed outlet boxes accurately to allow for surface finish thickness.

O. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.

P. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.

Q. Provide electrical connections for installed boxes.

R. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.

S. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.

T. Subsequent to installation of boxes, protect boxes from construction debris and damage.

U. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.

V. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscoting, shall be at a height to prevent interference to service equipment, or as noted on drawings.

3.4 GROUNDING

A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

3.5 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract.

B. Materials and Methods, Sections of Division 26.

C. Excavating, backfilling and Compacting and Division 3, concrete.

D. All excavation is unclassified.

E. Definitions:

1. Engineer: Soils Engineer employed by Owner and empowered to undertake necessary inspections and approvals.
2. Unclassified excavation: Excavate and grade all materials that can be removed without drilling or blasting.

1.2 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for all underground service and manholes as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of all other trades.

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

1.3 SUBMITTALS

A. Product data for the following: Electrical and Telecommunication Manholes, Duct Spacers.

B. Test reports as required for compaction and concrete work in Division 2, 3, and 31.

C. Submit pulling tension calculations for all underground feeders.

1.4 QUALITY ASSURANCE

A. Compaction density test: ASTM D1557.

B. Owner will hire an independent soils laboratory to conduct in place moisture-density tests to insure that all work complies with this specification.

1. Notify Construction Manager or Owner's representative at least 2 weeks prior to anticipated date of testing.
2. Contractor will pay additional cost if work is delayed due to their failure to notify Owner's agent as specified above.

C. Comply with all aspects of "Safety Rules & Regulations for Excavation: as promulgated by the state in which excavation will occur.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store conduit to avoid warping or deterioration.

B. Store plastic conduit on flat surface protected from direct rays of sun.

PART 2 - PRODUCTS

2.1 DUCT SYSTEM

A. Duct System: Multiple and single, conduits completely encased in concrete.

1. Separators: Plastic or other non-metallic, non-decaying material.
2. Select fill to confirm Division 3 requirements.

B. Pull Wire: No. 9 galvanized iron, or heavy nylon cord, free of kinks and splices.

2.2 PULL BOXES

A. Site Pull Boxes

1. Site landscape pull boxes shall be constructed of HDPE.
2. Pull boxes located in concrete drives, sidewalks, etc. shall be precast type with drive over lids.
3. Landscape box and cover shall be black.

PART 3 - EXECUTION

3.1 DUCT BANK

A. Form all duct banks in square or rectangular fashion as shown, and place concrete so that voids around ducts are filled.

B. Adjust final slopes on-site to coordinate with utilities and structure.

C. Install drain assembly with saddle cutouts for each conduit. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with ½-inch stainless-steel straps to conduit assembly to prevent mechanical displacement. Connect to (piping drain) washed gravel sump 36-inch square by 36-inches deep.

D. Install on undisturbed soil where possible. Use pit run gravel and sand, placed in 8-inch lifts and compacted for backfill.

E. After installation, clean and swab ducts.

F. Install galvanized steel pullwires in spare ducts. Cap empty ducts with screw covers.

G. Label conduit at stub-up and manhole penetrations in accordance with Section 26 05 53.

3.2 PULL BOXES

A. All pull boxes shall be sized to accommodate all incoming and outgoing conduits.

B. All pull boxes located in landscape areas shall include a gravel base to allow for drainage.

END OF SECTION 26 05 43

SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.2 MATERIAL AND EQUIPMENT

A. All vibration isolation mounts shall be supplied by one of the approved manufacturers stated in the PRODUCTS Section of this specification. Substitutions of equal equipment beyond the alternatives listed will be permitted only with the written permission of the Architect. Accompany each request for acceptance of substitute equipment with manufacturer's certified data proving the equivalence of the proposed substitute in quality and performance. The Architect shall be the final judge of the validity of the data submitted.

B. Unless otherwise specified, supply only new equipment, parts, and materials.

1.3 SUBMITTALS

A. Refer to related sections elsewhere for procedural instructions for submittals.

B. The shop drawing submittal for isolated electrical equipment shall include submittal information for the isolation mounts. Information supplied shall be as follows:

1. A complete description of products to be supplied including product data, dimensions, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:

    a. The equipment identification mark.
    b. The isolator type.
    c. The actual load.

C. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job. All costs associated with submission of samples shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.

C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.

D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

E. Should any electrical equipment cause excessive noise or vibration, the Contractor shall be responsible for remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

F. Upon completion of the work, the Architect or Architect's representative shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION MOUNT TYPES

A. Type DNP (Double Neoprene Pad):

1. Neoprene pad isolators shall be formed by two layers of ¼" to 5/16" thick ribbed or waffled neoprene, separated by a stainless-steel or aluminum plate. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type DNP isolators shall be formed from one of the following products or approved equal:

Type NR	Amber/Booth
Type Korpad	Korfund Dynamics
Type WSW	Mason Industries
Type NPS	Kinetics Noise Control
Series Shear Flex	Vibration Mountings & Control

B. Type HN (Hanger Neoprene):

1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be

provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing.

2. Type HN isolators shall be one of the following products or approved equal:

Type BRDA	Amber/Booth
Type H	Korfund Dynamics
Type HD	Mason Industries
Type RH or FH	Kinetics Noise Control
Type RHD or RFD	Vibration Mountings & Control

2.2 FLEXIBLE ELECTRICAL CONNECTIONS

A. Type A:

1. Flexible Electrical Connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
2. Flexible Electrical Connection Type A shall be Crouse-Hinds (Syracuse, NY) “XD Expansion/Deflection Coupling,” Spring City Electrical Mfg. Co. (Spring City, PA) “Type DF Expansion and Deflection Fitting,” or approved equal.

B. Type B:

1. Flexible Electrical Connection Type B shall be field fabricated using a minimum 2 (two) foot length of flexible conduit or cable.

C. Type C:

1. Flexible Electrical Connection Type C shall be field fabricated using a minimum 4 (four) foot length of flexible conduit or cable.

PART 3 - EXECUTION

3.1 APPLICATION

A. Transformers, Unit Substations, and Uninterruptible Power Supplies (UPS):

1. Transformers, Unit Substations, and UPS devices within the building construction shall follow the following table:

Transformers	Base Type	Isolator Type	Static Defl (in.)	Mason Industries Type
Suspended – 45 to 350 kVA	Trapeze	Spring	1	30N
Suspended – Less than 45 kVA		Neoprene	0.05	W

2. Electrical connections to isolated transformers and UPS devices shall be made using flexible electrical connections Type A or Type B.

B. Mechanical Equipment:

1. Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections Type A or Type C.

3.2 INSTALLATION

A. General:

1. In all cases, isolated electrical equipment shall be positioned so that it is free standing and does not come in rigid contact with the building structure or other systems.

B. Isolation Mounts:

1. All mounts shall be aligned squarely above or below mounting points for the supported equipment.
2. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
3. Hanger rods for vibration isolated supports shall be connected to structural beams or joists, not to the floor slab between beams and joists. Provide suitable intermediate support members as necessary.
4. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.

C. Flexible Electrical Connections:

1. Type C connections shall be installed in a grossly slack “U” shape or a 360 loop.
2. Rigid conduit on the isolated-equipment side of the flexible connection, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

END OF SECTION 26 05 48

SECTION 26 05 53 - IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 26 Sections apply to this Section:

1. "Electrical Requirements."

1.2 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:

1. Buried electrical line warnings.
2. Identification labeling for raceways, cables, and conductors.
3. Operational instruction signs.
4. Warning and caution signs.
5. Equipment labels and signs.

B. Related Sections: The following Sections contain requirements that relate to this Section;

1. Division 9 Section "Painting" for related identification requirements.
2. Division 26 Section "Electrical Power Conductors Cables" for requirements for color coding of conductors for phase identification.

C. Refer to other Division 26 Sections for additional specific electrical identification associated with specific items.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data for each type of product specified.

C. Schedule of identification nomenclature to be used for identification signs and labels.

D. Samples of engraved, plastic laminate to be used on switchgear, switchboards, disconnect switches and panelboards.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS

A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mil thick by 1 inch to 2 inches in width.

B. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic tape with magnetic tracer strip not less than 6-inches wide by 4-mil thick. Printed legend indicative of general type of underground line below.

C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wrap around, cable/conductor markers with preprinted numbers and letters.

D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for sign up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal power and white letters on red face for emergency and standby power. Plastic laminate shall be punched for mechanical fasteners. Refer to details on drawings for exact information requirements.

E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide ¼-inch grommets in corners for mounting.

G. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or number 10/32 stainless-steel machine screws with nuts and flat and lock washers.

H. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.

I. Electronic Labels: Self-adhesive, 3/16-inch-industrial label, black on clear for normal circuits and red on clear for emergency/standby circuits. Acceptable manufacturers include the following:

1. Brother
2. Kroy

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.2 IDENTIFICATION

A. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also, label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels at concealed boxes.

B. Underground Electrical Line Identification: During trench backfilling, for underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches; install a single line marker.

C. Install line marker for underground wiring, both direct-buried and in raceway.

D. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inches-wide, completely encircling conduit, and place

adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:

1. Fire Alarm Systems: Red.
2. Fire Suppression Supervisory and Control System: Red and Yellow.
3. Tag or label conductors as follows:

    a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and intent.
    b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure label each conductor or cable. Provide label on each box indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
    c. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facilities' electrical installations.

E. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

F. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

208/120-Volts	Phase	480/277-Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

G. Use conductors with color factory-applied the entire length of the conductors except as follows:

1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:

    a. Apply colored, pressure-sensitive plastic tap in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

2. All grounded conductors No. 6 AWG and smaller shall be a factory applied color across the entire length of conductors.

H. Power Circuit Identification:

1. Securely fasten wrap-around marker bands to cables, feeders, and power circuits in pull boxes, junction boxes, and switchgear rooms.

I. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, or instruction signs where required by NEC where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
3. Arc Flash Labels: All electrical equipment shall be marked with a label consisting of the following information:

a. Nominal voltage.
b. Available fault current at the equipment.
c. Clearing time.
d. Arc flash hazard boundary.
e. Flash hazard at 18”.
f. PPE (Personnel protective equipment) level.
g. Distance of limited approach.
h. Distance of restricted approach.
i. Distance of prohibited approach.
j. Date label is applied or calculations were performed.

J. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit for electrical equipment. This includes communication/signal/alarm system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 3/8-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), black lettering in white field for normal power and red lettering on white field for emergency and standby power. Text shall match

terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment:

a. Panelboards, electrical cabinets, and enclosures.

1) Labels shall include at a minimum: voltage, phase, ampacity, AIC rating, available fault current (and when it was calculated) and where the equipment is fed from. **Refer to detail on drawings for additional information.**

b. Access doors and panels for concealed electrical items.
c. Electrical switchgear and switchboards.

1) Labels shall include at a minimum: voltage, phase, ampacity, AIC rating, available fault current and where the equipment is fed from. **Refer to detail on drawings for additional information.**

d. Motor starters, motor control centers.
e. Pushbutton stations.
f. Power transfer equipment.
g. Contactors.
h. Remote-controlled switches.
i. Dimmers.
j. Control devices.
k. Transformers.

1) Include on label, location of primary overcurrent protection device.

l. Power generating units.
m. Telephone switching equipment.
n. Fire alarm master station or control panel.
o. Lighting control panel.
p. Static uninterruptable power supply

2. Apply electronic label on the outside of all receptacle and switch plates. The labels shall identify circuit and panelboard.
3. All emergency circuits shall be permanently marked as emergency as indicated below:

a. Junction Boxes – with permanently fastened labels.
b. Raceways – with permanently fastened labels at intervals of not more than 25ft.

K. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification (including room numbers) of items controlled by each individual breaker.

L. Fire Pump Service Identification: A placard shall be externally installed on the Fire Pump primary disconnecting means stating, “Fire Pump Disconnecting Mean.” The lettering shall be at least one inch in height. In addition, a placard shall be placed adjacent to the Fire Pump controller stating the location of this disconnecting means and the location of the key (if the disconnecting means is locked).

M. Electrical Service Room Distribution Placard: In each of the main electrical rooms, provide a single line riser diagram placard of the entire electrical distribution fed from that room. The placard shall also identify where other services are located per NEC 230.2(e). The riser diagram shall be framed under glass and mounted on the wall in the electrical room. The print shall be of diffusion transfer process to eliminate fading.

END OF SECTION 26 05 53

SECTION 26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this section.

B. Requirements of the following Division 26 Sections apply to this section.

1. "Electrical Requirements."

1.2 SUMMARY

A. This section includes general purpose and specialty dry type transformer with winding rated 600V or less, with capacities up to 1000 KVA.

B. Related Sections: The following Division 26 Sections contain requirements that relate to this section:

1. "Electrical Identification" for signs associated with transformer installations.

C. All switchboards, panelboards, switchgears, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project unless specifically noted otherwise.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:

1. Product data for each transformer, including dimensional floor plans of electrical rooms, sections, and elevations showing minimum clearances, installed devices, and material lists.
2. Transformer physical characteristics, including dimensions, weight, KVA rating, voltage, % impedance, taps, insulation class and sound levels.
3. Wiring diagrams from manufacturer differentiating between manufacturer-installed and field-installed wiring.
4. Transformer no-load losses and efficiency ratings.
5. Product certificates, signed by manufacturer of transformers certifying that their products comply with the specified requirements.

6. Product Test Reports: Certified copies of manufacturer's design and routine factory tests required by the referenced standards.

1.4 PROJECT RECORD DOCUMENTS

A. Maintain a redline set of contract documents noting all revisions and deviations that are made during the course of the project.

B. Manufacturer shall provide copies of installation, Operation and Maintenance (O&M) procedures to owner in accordance with general requirements of Division 01 and Division 26.

C. Submit O&M data based on factory and field testing, operations and maintenance of specified product.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: A firm member of NEMA who is regularly engaged in manufacturing components that comply with the requirements of these Specifications and that have been used on at least five projects of similar size and scope as this Project.

B. Field Testing Organization Qualifications: To qualify for acceptance, an independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

1.6 REFERENCES

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. ANSI/IEEE C57.96, Distribution and Power Transformers, Guide for Loading Dry-Type appendix to ANSI C57.12 standards.

C. ANSI/IEEE C89.2 – Dry Type Transformers for General Application.

D. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers including those with Solid Cast and/or Resin-Encapsulated Windings.

E. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers

F. 2016 10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Distribution Transformers

G. NEMA ST 20, Dry-Type Transformers for General Applications.

H. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.

I. Nationally Recognized Testing Laboratory Compliance (NRTL): Items provided under this section shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle transformer in accordance with the manufactures recommendations.

B. Transformers shall be located in well-ventilated areas, free from excess humidity, dust, dirt hazardous materials. Transformer shall be protected to prevent moisture from entering enclosure.

C. Transformer shall be shipped with edge and top protection that is adequate to protect the transformer enclosure from common dents and scratches.

1.8 WARRANTY

A. Manufacturer warrants equipment to be free from defects in material and workmanship for 1 year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE, DRY-TYPE DOE 2016 TRANSFORMER

A. Comply with NEMA Standard ST 20 "Dry-Type" Transformers for General Applications.

B. Transformers: Factory assembled and tested air cooled units of types specified, having characteristics and ratings as indicated on drawings. Units shall be designed for ratings as indicated in drawings and for 60 Hz service.

C. Cores: Core construction shall be of Grain oriented, non-aging silicon steel with high permeability, low hysteresis and low eddy current losses as need to achieve required efficiency levels. Core laminations shall be tightly assembled and magnetic flux densities shall be kept well below the saturation point.

D. Coils: Continuous windings without splices except for taps.

E. Internal Coil Connections: Brazed or pressure type.

F. Provide high quality copper windings. Wiring compartment and termination shall be accessible by removing enclosure front panels. Three phase transformers shall use one coil per phase in primary and secondary windings.

G. Transformers shall meet the energy efficiency requirements of 2016 10 CFR Part 431. The use of fans to obtain rated KVA or any published rating shall not be permitted for all transformer types.

H. Efficiency at 35% nameplate ratings shall meet or exceed:

1. 15 KVA –97.89%
2. 30 KVA – 98.23%
3. 45 KVA – 98.40%
4. 75 KVA – 98.60%

I. Sound Level: Sound levels shall not exceed the following: 150 KVA and below, 50 db; above 150 KVA, 60 db.

J. Transformers shall have the following features and ratings:

1. Enclosures shall meet UL 506 requirements.
2. Enclosure: Indoor, ventilated, drip proof in electric rooms.
3. Enclosure: Outdoor, ventilated raintight, NEMA 3R.
4. Insulation Class: 185°C class for 37½ KVA transformers or smaller; 220°C class for transformers larger than 37½ KVA.
5. Insulation Temperature Rise: 150°C maximum rise above 40°C, for 220°C class insulation; 115°C maximum rise for 185°C class insulation.
6. Taps: For transformer 3KVA and larger, full capacity taps in high-voltage winding as follows:

    a. 3 KVA through 30 KVA: Four 2.5% taps, two above and two below normal voltage.
    b. 30 KVA through 500 KVA: Four 2.5% taps, two above and two below rated normal voltage.

K. Accessories: As follows:

1. Weather shield kits for the ventilated transformer Type 3R.

L. Transformers: Factory assembled and tested air cooled units of types specified, having characteristics and ratings as indicated on drawings. Units shall be designed for 60 Hz service.

M. Transformer core shall be constructed of high grade grain oriented silicon steel.

N. Coils shall use high grade magnet wire. Coils shall have clearly marked terminal pads attached to a rugged fiberglass termination strip. Windings shall be vacuum impregnated with nonhydroscopic thermosetting varnish for superior strength and heat transfer.

O. Transformer shall have (2) 2.5 percent above nominal and (4) 2.5 percent below nominal universal full capacity taps.

P. Insulation system shall be UL Recognized at 220 degree C and shall be capable of continuous operation at 40 degree C ambient without windings exceeding 150 degree C temperature rise. Surface temperature rise shall not exceed UL 50 degree C limit. Wiring compartment temperature rise shall not exceed UL 35 degree C limit.

Q. Floor-mount enclosure shall be constructed of heavy-gauge steel for indoor use. Weathershield kits shall be available to modify enclosures for NEMA 3R outdoor use.

R. Wiring compartment shall be sized for aluminum cable rated 125 percent of current, using long shanked crimp type connectors. Wiring compartment shall be accessible by removing enclosure front panel.

S. Vibration from core and coil assembly shall be isolated from enclosure by neoprene vibration pads and sleeves. A flexible copper grounding strap shall connect core to enclosure. A schematic connection diagram shall be located on enclosure nameplate for quick referral.

T. A premium electrostatic shield shall be included, consisting of a full width copper sheet placed between primary and secondary windings. Effective coupling capacitance shall be thirty picofarads. Average common mode noise attenuation shall be 120 db.

U. A rugged filter shall provide an average 60 db normal mode noise attenuation.

V. Surge suppression components shall be included to eliminate low-voltage spikes and surges.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arrange equipment to provide adequate spacing for cooling air circulation.

B. Identify transformers in accordance with Division 26 Section “Electrical Identification.” Include on label, location of primary overcurrent protection device.

C. Tighten electrical connectors and terminals in accordance with manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 EQUIPMENT BASES

A. Construct concrete equipment pads as follows:

1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4-inches high and 2-inches larger in all directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 4000 psi compressive strength, and normal weight aggregate.

3.3 STRUCTURAL REVIEW

A. Based on submitted transformers, the Contractor shall submit intended structural support details to the project structural engineer to review to confirm structure is adequate.

3.4 GROUNDING

A. Ground transformers and tighten connections to comply with torque tightening requirements specified in UL Standard 486A.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, broken insulation, tightness of connections, defective wiring, and general condition.

B. Thoroughly clean unit prior to making any tests.

C. Perform insulation-resistance test. Calculate dielectric absorption ratio and polarization index. Make measurements from winding-to-winding and winding-to-ground. Test voltages and minimum resistance shall be in accordance with Table below:

Minimum dc Test Voltage	Recommended Minimum Insulation Resistance in Megohms
1000-Volts	500

D. Verify taps and connect transformer to desired tap, if applicable.

E. Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.

F. All transformers shall have a disconnecting means on the primary side of the transformer. If the disconnecting means is in a remote location or not within direct line of site of the transformer, the contractor shall provide a permanent phenolic label on the transformer with ¾" black lettering on a white background. The label shall indicate the room name and number indicating where the remote disconnect is located.

3.6 INFRARED INSPECTION (AFTER ENERGIZED)

1. The scan is to include all electrical distribution equipment.
2. All equipment should be energized at normal load levels during an event for at least 1 to 2 hours prior to being scanned.
3. Access covers are to be removed and reinstalled by the electrical Contractor for the testing agency to inspect and scan all electrical junctions, buss, and cable.
4. The IR Scan will be made using a Flir Thermal Imaging Camera. The camera shall provide infrared photos clearly indicating problem areas.
5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and digital pictures of all problem areas.

3.7 ADJUSTING AND CLEANING

A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paint splatters and other spots, dirt and construction debris. Touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 26 22 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Provide all panelboards and enclosure work, including cabinets and cutout boxes, as indicated by drawings and schedules, and a specified herein.

B. Types of panelboards, and enclosures required for the project include the following:

1. Power-distribution panelboards.
2. Lighting and appliance panelboards.

C. All switchboards, panelboards, switchgears, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project unless specifically noted otherwise.

D. Wires/cables, bus-way, electrical boxes and fittings, and raceways required in conjunction with the installation of panelboards, and enclosures are specified in other Division 26 sections.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s data on panelboards, and enclosures.

B. Wiring Diagrams: Submit wiring diagrams for panelboards showing connections to electrical power feeders and distribution branches.

C. Submit electrical room plan view drawings at ¼” scale showing all equipment, panelboards, disconnects and ratings, buss work, conduit areas, dimensions and mounting of equipment supplied.

D. Shop drawings showing dimensions, voltage, phasing, continuous current capacity, and short circuit rating.

E. The equipment product data, electrical room layouts and short-circuit study shall be submitted together in order to provide proper evaluation.

F. Submittals shall be in accordance with specification section 26 05 00.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer of this equipment shall be regularly engaged in manufacture of panelboards and enclosures, of types, sizes, and ratings required and have produced similar electrical equipment, for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Codes and Standards

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Article 384 as applicable to installation, and construction of electrical panelboards and enclosures.
2. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards", and UL's 50, 869, 486A, 486B, 891, and 1053 pertaining to panelboards, accessories and enclosures. Provide panelboard units which are UL-listed and labeled.
3. Special-Use Markings: Provide panelboards, constructed for special-use, with appropriate UL markings which indicated that they are suitable for special type of use/application.
4. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosure for Electrical Equipment (1000-Volts Maximum)", Pub/No. PB 1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600-Volts or Less".

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store panelboards in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.

B. Handle panelboards carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of panelboards and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

PART 2 - PRODUCTS

2.1 PANELBOARDS (800 AMPS OR LESS)

A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated on drawings, which comply with manufacturer's standard materials; with the design and construction in accordance with published product information; equip with proper numbers of unit panelboard devices as required for complete installation.

1. Prefabricated or pre-wired panelboards are not acceptable.

B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboards switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with copper buss bars with not less than 98% conductivity, and with full-sized neutral buss; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connection. Provide molded-case main and branch circuit-breaker types for each circuit, with toggle handles that indicated when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Where multiple single pole breakers share a common neutral conductor, provide breaker tie bars as required so overload on one pole will trip all poles simultaneously. Provide panelboards with bare un-insulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which mate and match properly with panelboards. Employ bolt on breakers that are fully rated for the available short-circuit condition but of not less than 22,000 sym AIC.

C. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown. Equipped with anti-turn solderless pressure type lug connectors approved for use with copper conductors; construct unit for connecting feeders at top of panel; equip with copper buss bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole circuit breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral buss for each outgoing feeder required; and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which mate and match properly with panelboards.

1. Employ breakers that are fully rated for the available short-circuit condition but not less than 10,000 sym AIC at 120/208-Volts; and 14,000 sym AIC at 277/480-Volts.
2. Where multiple single pole breakers share a common neutral conductor, provide breaker tie bars as required so overload on one pole will trip all poles simultaneously.
3. All circuit breakers feeding food service loads or vending machines shall be GFCI type.

D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush

locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges with door in door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for surface mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

E. Molded-Case Circuit Breakers: Provide factory-assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and ampere ratings as indicated on the drawings. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in ambient temperature of 40°C. Provide breakers with mechanical screw or compression type removable connector lugs, AL/CU rated. The breakers for 277/480V panelboards shall be industrial grade; breakers that allow or direct particles of combustion resulting from fault conditions out of the breaker are not acceptable, they shall be contained within its casing. For example; GE AE series panelboards with TEY circuit breakers are not acceptable, TED breakers are acceptable.

1. Breakers feeding the primary side of a transformer shall have provisions for locking the breaker on or off.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine area and conditions under which panelboards and enclosures are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation" and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque tightening requirements specified in UL Standards 486A and B.

C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

D. Provide properly wired electrical connections for panelboards within the enclosures.

1. Prefabricated or pre-wired panelboards are not acceptable.

E. Provide engraved, plastic laminate labels for all panelboards indicating name, voltage, phase, wire and short circuit rating. Refer to Section 26 05 53 for more information.

F. At all recessed panel locations, provide three ¾" spare conduits stubbed to the accessible ceiling space for future use.

G. Provide typed panelboards circuit directory card upon completion of installation work to match as-built conditions and nomenclature indicated on engineering drawings and submit directories to the Engineer for review prior to mounting in panelboard.

3.3 GROUNDING

A. Provide equipment grounding connections as indicated herein. Tighten connection to comply with torque tightening requirements specified in UL Standard 486A to assure permanent and effective grounds.

B. Refer to Section 26 05 26 for additional grounding requirements.

3.4 FIELD QUALITY CONTROL

Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment".

A. Infrared Inspection (After Energized)

1. The scan is to include all electrical panelboards or bussed distribution equipment.
2. All equipment should be energized at normal load levels during an event for at least 1 to 2 hours prior to being scanned.
3. Access covers are to be removed and reinstalled by the electrical Contractor for the testing agency to inspect and scan all electrical junctions, buss, and cable.
4. The IR Scan will be made using a Flir Thermal Imaging Camera. The camera shall provide infrared photos clearly indicating problem areas.
5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and digital pictures of all problem areas.

B. Panelboards:

1. Visual and Mechanical Inspection:

a. Inspect for physical damage and code violations.
b. Inspect for proper alignment, anchorage and grounding.
c. Inspect for proper identification of protective devices and switches.

d. Check tightness of accessible bolted buss joints.
e. Physically test all electrical or mechanical interlocks to assure proper function.
f. Clean interior and insulator surfaces once a month prior to job completion.
g. Inspect for proper operation of space heaters and thermostat settings (if they exist).

2. Electrical Tests:

a. Measure insulation resistance of each buss section phase-to-phase and phase-to-ground.
b. Check panelboards for electrical continuity of circuits and for short circuits.

3.5 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finishes.

3.6 DEMONSTRATION

A. Subsequent to wire and cable hook-ups, energize and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 26 Sections apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles
2. Ground-Fault Circuit-Interrupter Receptacles
3. Plugs
4. Plug Connectors
5. Snap Switches
6. Wall Plates

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 26 Section “Motor Disconnects and Fuses” for devices other than snap switches and plug/receptacle sets used as disconnects for motors.

1.3 SUBMITTALS

A. Product data for each type of product specified.

B. Shop Drawings / Architectural Coordination Requirements:

1. Floor box locations and types indicated on drawings are schematic in nature and are not dimensioned locations. Contractor shall submit shop drawings and product data for final review and comment by the Architect, Owner, and Engineer, to ensure desired aesthetics are achieved.
2. Shop drawings shall include the following detailed information:

    a. Conduit: Show all conduit size and routing with labels for power, data, etc.
    b. Covers: Specific labels or notes to indicate where different cover types and finish are to be used, if applicable.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following codes.

1. NFPA 70 “National Electrical Code.”

B. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL, Federal Specification and comply with applicable UL and NEMA standards.

1. UL 943

1.5 SEQUENCE AND SCHEDULING

A. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards.

B. Color of Devices: Color of all devices shall be coordinated with the Architect, except special purpose devices shall be black, Stand-by power system devices which shall be red.

C. Receptacles: As scheduled in Table 1 in Part 3 indicated herein. Comply with UL 498 and NEMA WD 1 and WD 6. Damp and wet location receptacles to be listed as weather resistant. Plug tail devices are not acceptable.

D. Receptacles, Industrial Heavy Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.

E. Receptacles, USB charging type: 2 port, 5 Amp minimum, 5-Volt D.C, WR rated as required.

F. Ground-Fault Circuit-Interrupter (GFCI) Receptacles: As scheduled in Table 1 in Part 3 indicated herein: Provide “terminal” or feed-through type ground fault circuit interrupter, as indicated on drawings, with integral heavy-duty NEMA 5-20R duplex receptacles. Provide unit designed for installation in a 2-3/4-inch-deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943 including self-testing.

G. Snap Switches: As scheduled in Table 2 in Part 3 indicated herein.

H. Wall Dimmer: As scheduled in Table 2 in Part 3 indicated herein.

1. Incandescent wall dimmers shall be 120-Volt, solid state type with slide control handle, preset button and semi-flush mounting. Dimmers shall be sized to continuously carry the load they are connected to, the minimum size shall be 1000 watts, and shall be rated larger if indicated on the drawings or required to serve the load.
2. Dimmers indicated on the drawings to serve low-voltage incandescent lamps shall be the same as specified for incandescent lamps and in addition shall be specifically rated for the low-voltage transformer load. Dimmer shall be UL listed for use with low-voltage fixtures.
3. Dimmers indicated to serve fluorescent lamps shall be 120v or 277v, as required for circuit served, solid state type for use with fluorescent dimming ballasts. Control shall be slide handle and dimmer shall be for semi-flush mounting.
4. Dimmers indicated to serve 0-10V loads shall be 120V or 277V, as required for circuit served, solid state type for use with 0-10V ballasts/drivers. Control shall be slide handle and dimmer shall be for semi-flush mounting.
5. All dimmers shall be of the same manufacturer. Faceplate shall be the same color as device plates specified.

I. All exterior weatherproof receptacles located on the roof, receptacles located in elevator pits and machine rooms shall be GFCI type or GFCI protected and have cast metallic “in use” covers.

J. All devices shall be premium specification grade.

2.2 WIRING DEVICE ACCESSORIES

A. Wall Plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide plates possessing the following additional construction features:

1. Material and Finish: 0.03-inch-thick, type 302 satin finished stainless steel. Plate shall be Hubbell “S” Series or approved equal.
2. Emergency receptacles shall have red cover plates.

B. For all devices installed which are exposed to the weather, moisture or where indicated on the drawings, device plates shall be weatherproof. Device cover plates shall be cast metallic in-use type with gasketing to prevent entrance of moisture when closed.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES AND ACCESSORIES

A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.

C. The mounting height of devices is indicated in the legend on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.

D. Receptacles above countertops shall be installed with major axis horizontal above the backsplash.

E. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominant building feature, i.e., door frames or countertops.

F. Install wall switches on the strike side of doors.

G. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.

H. Provide a current carrying conductor, neutral, equipment grounding conductor and an insulated grounding conductor to each isolated ground "IG" receptacle.

I. Install galvanized steel wall plates in unfinished spaces.

J. Install wiring devices after wiring work is completed.

K. Install wall plates after painting work is completed.

L. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminal to comply with tightening torque requirements specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

M. Provide hardwire connection to all modular furniture system power entry cables.

3.2 PROTECTION

A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.3 FIELD QUALITY CONTROL

A. Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing test wiring devices and demonstrating compliance with requirements, operate each operable device at least six times.

B. Test ground-fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

C. TABLE 1

RECEPTACLES

Designation (1)	Current Rating Amps	Voltage Rating	Single/ Duplex	NEMA Config.	Hubbell Catalog #(3)	Notes
-	20	125	Duplex	5-20R	HBL5362	-
-	20	125	Single	5-20R	HBL5361	-
-	20	125	Duplex	5-20R	HBL5362C2	(7)
USB	20	125	Duplex	5-20R	USB20AC5	(6)
IG	20	125	Duplex	5-20R	IG5362	Isolated Ground
WP	20	125	Duplex	5-20R	GFR5362SG/ WP826 (4)	In Use Weather-proof
GFCI	20	125	Duplex	5-20R	GF5362SG	Integral GFCI (2)
-	20	125	Duplex	5-20R	HBL5362SA	Surge Suppression
-	20	125	Duplex	5-20R	HBL8300SGA	Tamperproof

NOTES

1. Letter designations are used where symbols alone do not clearly designate on plans locations where specific receptacle types are used.
2. Protecting downstream receptacles on same circuit is not acceptable.
3. Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.). All emergency receptacles shall be red.

4. Where required per NEC or local code, provide Hubbell 'WP26E' in-use water-proof cover for two-gang devices.
5. Where receptacles are located in damp or wet locations per article 406 in the National Electric Code, provide receptacles that are listed weather resistant. Use Hubbell HBL5362WR or approved equal receptacles where GFCI is not required at the receptacle location. Use Hubbell GFR5362 or approved equal where GFCI is required at the receptacle location.
6. Provide USB20AC5WR as required where weather resistance is needed.
7. Controlled receptacles shall be marked with power symbol and labeled as "Controlled" as required by the NEC 406.3E.

D. TABLE 2

SNAP SWITCHES

Designation (1)	Typical Application	Load Rating	Voltage Rating (AC)	Poles	Hubbell Catalog #(3)	Notes
S	Control Lights	20A	120/277	1	HBL1221	-
S3	Control Lights	20A	120/277	3-way	HBL1223	-
S4	Control Lights	20A	120/277	4-way	HBL1224	
Sp	Switch and Pilot Light	20A	120/277	1	HBL1221PL	(2)
Sk	Key Switch	20A	120/277	1	HBL1221L	
Swp	Wp Switch and Cover Plate	20A	120/277	1	HBL1281/HBL 1750	

NOTES

1. For snap switches, designation is the same as the symbol used on plans for the device. Type of switch is determined from plan context including type of device or circuit being controlled.
2. Pilot light "on" when switch is "on."
3. Hubbell basis of design. Refer to Section 26 05 03 for additional acceptable manufacturers. Color of device shall be verified with Architect (black, gray, white, etc.).

END OF SECTION 26 27 26

SECTION 26 32 14 - GAS-ENGINE DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26 Basic Electrical Materials and Methods Section 26 05 02 apply to work specified in this section.

C. Division 26 Automatic Transfer Switches Section 26 36 23 to be coordinated with work specified in this section.

1.2 SUMMARY

A. Extent of natural gas generator set work is indicated by drawings and is hereby defined to include, but not by way of limitation, gas engine, electrical generator, engine starting system including batteries, instrument control panel, transfer switches, annunciator panel, exhaust silencer, wall thimble, and accessories.

B. Refer to Division 3 sections for concrete and grout work required in connection with pads for engine-driven generator set; work of this section.

C. Refer to Division 23 sections for fuel tank piping and associated accessories required for installation of gas engine-generator unit.

D. All generator work shall be coordinated with piping, ducting, and exhaust requirements.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s data on gas engine-driven generator sets and components. Include manufacturer’s standard product warranty, for duration of not less than two-years from substantial completion, for replacement of materials and equipment used in gas generator systems.

B. Shop Drawings: The Contractor shall submit copies of pertinent drawings and schematic diagrams for approval and shall include the following:

1. Engine generator set including plans and elevations or riser views clearly indicating entrance points for each of the interconnections required.
2. SL2 Acoustic steel housing showing all pertinent dimensions and details.

3. Engine generator/exciter control cubicle.
4. Fuel consumption rate curves at various loads, ventilation and combustion CFM requirements.
5. Generator power delivered calculation at project elevation.
6. Exhaust muffler and vibration isolators.
7. Battery charger, battery, and battery rack.
8. Fuel supply connection points.
9. Automatic load transfer switch.
10. Legends for all devices on all diagrams.
11. A complete 1/2" = 1'-0" scaled site specific plans and sections showing the exact generator and transfer switch system layout including all components and accessories being provided or required for operation as specified herein coordinated with Architectural, Structural, Mechanical, Plumbing and other plans, showing operational and maintenance clearance. Include in place, receptacles, lighting fixtures, and other items pertinent to the complete installation.
12. Generator mounted circuit breaker(s).

C. Wiring Diagrams: Submit wiring diagrams for gas engine-driven generator unit showing connections to electrical power panels, feeders, automatic transfer switches, and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.

D. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit an agreement for continued service and maintenance of gas engine-driven generator sets, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

E. Certifications: Provide gas engine-drive generator sets certified test record of the following final production testing:

1. Single-step load pickup.
2. Transient and steady-state governing.
3. Safety shutdown device testing.
4. Voltage regulation.
5. Rated power.
6. Maximum power.

F. Provide a letter indicating the manufacturer has reviewed the installation conditions (maintenance clearances, combustion air intake and radiator discharge clearances, etc.) and confirm that the generator can deliver the 100% specified rated output capacity as shown on the shop drawing. Not submitting the letter will be cause for rejection of the submittal.

G. Electronic PDF to include bookmarks to each section of submittal requirements.

1.4 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of gas engine-driven generator units and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years. Manufacturer shall be certified to ISO 9001.

B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with gas engine-driven generator units similar to that required for this project.

1. Agreement to Maintain: Engage Installer who is willing to execute with the Owner, required agreement for continued maintenance of gas engine-driven generator units.

C. Generator Supplier Qualifications: Generator supplier shall be factory-authorized distributor nearest to the project location for the system being provided. There shall be a distributor service location for the generator manufacturer within a driving distance of 200 miles. Generator supplier shall certify that they employ at least two technicians who have attended all factory service schools. Supplier shall certify that they offer 24-hour, 7-day field service and maintain the manufacturer's recommended parts inventory on all field service vehicles, as well as a complete recommended service parts stock at their location nearest the project.

D. Codes and Standards:

1. Electrical Codes Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 700, 701, and 702 pertaining to construction and installation of emergency and standby systems.
2. Gas generators shall be listed in accordance with UL 2200.
3. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures", and NFPA 110, "Standards for Emergency and Standby Power Systems".
4. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches," UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," UL 486B, "Wire Connectors for Use with Aluminum Conductors," and UL 6200 "Standard of Controllers for Use in Power Production."
5. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1 "Motors and Generators," and MG 2, "Safety and Use of Electric Motors and Generators".

E. NEMA Compliance: Comply with applicable requirements of NEMA's Standard Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)."

F. IEEE Compliance: Comply with applicable portions of IEEE Standard 446, "IEEE Recommended Practices for Emergency and Standby Power Systems for Industrial and Commercial Applications."

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver generator properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for engine-generator and components which protect equipment from damage.

B. Store generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Performance:

1. Standby kw Refer to drawings
2. Power factor 0.8
3. Speed 1,800 RPM
4. Generator output voltage 277/480-Volt, 3-phase, 4-wire, 60Hz.
5. Units shall be certified by the manufacturer to provide the rated kw at project altitude and 120 degree Fahrenheit ambient temperature.
6. It is intended that all products specified herein be of standard ratings, therefore the kw and kVA ratings, ampere ratings, withstand and closing ratings, etc., shall be the manufacturer's next larger size or rating when the specifications cannot be exactly met.
7. In a standby power capacity, the unit shall be capable of continuous service at rated output for the duration of any utility power failure. The engine and generator shall be the product of a single manufacturer; and that manufacturer and its authorized dealer shall have the responsibility to provide the gas engine/generator set and its accessories which will meet the specified output at the required altitude and ambient temperature. It shall be a new factory assembled and tested set. It is the intent and purpose of these specifications to also secure for the Owner, the necessary controls and accessories to the extent that this equipment, in conjunction with the gas/engine/generator set, will comprise a complete operating package unit.
8. Rating of the gas engine/generator set shall be based on operation of the set when equipped with all necessary operating accessories, such as radiator fan, air cleaners, lubrication oil pump, jacket water pump, governor, charging generator, alternating current generator, and exciter regulator. These ratings must be substantiated by manufacturer's standard published curves and test data. Special ratings or maximum ratings are not acceptable.

9. Voltage regulation shall be +/-1.0 percent of rate voltage for any constant load between no load and rated load.
10. Frequency regulation shall be +/-0.5 percent from steady state no load to steady state rated load.
11. Total Harmonic distortion: The sum of AC voltage waveform harmonics, from non-load to full linear load, shall not exceed 5% of rated voltage (L-N, L-L, L-L-L) and no single harmonic shall exceed 3% of rated voltage.
12. Telephone Influence Factor: TIF shall be less than 50 per NEMA MG1-22.43.
13. The gas engine-generator set shall be capable of single step load pick up of 100% nameplate kw and power factor, with the engine-generator set at operating temperature.
14. Motor starting capability shall after an initial instantaneous voltage dip not to exceed 15 percent.

B. Engine:

1. The engine shall be a stationary, liquid cooled, four-cycle design, vertical inline or V-type, with Dry exhaust manifolds.
2. The engine shall be equipped with lube oil, and intake air filters, lube oil cooler, service meter, gear driven water pump, and unit-mounted instruments, including a water temperature gauge, and lubrication oil pressure gauge. All emissions shall exceed all EPA and local emissions requirements.
3. Governor - The engine governor shall maintain frequency regulation not to exceed +/-0.25% from no load to full rated load. Units shall be furnished with and electronic isochronous governor.
4. Mounting - The unit shall be mounted on a structural steel sub-base and shall be provided with suitable integral vibration isolators.
5. Lubrication System: Engine or skid mounted.

    a. Filter and Strainer: Select according to engine manufacturer's requirements for particle removal.
    b. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
    c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

6. Safety Devices - Safety shut-offs for high water temperature, low oil pressure, low coolant temperature, low fuel, overspeed, and engine overcrank shall be provided. Alarm for low coolant level.
7. Engine-mounted battery charging alternator and solid-state voltage regulator.
8. Accessories: Provide replaceable type oil filters, dry-type air cleaners, lubricating oils, greases, and coolant.
9. All rotating parts shall be guarded against accidental contact.

C. Alternator:

1. The alternator shall be rated for continuous standby service at 0.8 power factor, 277/480-Volts, three phase, four wire, 60 hertz, 1800 RPM. The unit shall be capable of 100% block load per NFPA 110.
2. The A.C. generator shall be; synchronous, four-pole, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s). The stator shall have skewed laminations of insulated electrical grade seal, two thirds pitch windings. The rotor shall have amortissuer (damper) windings. The rotor shall be dynamically balanced. The exciter shall be brushless, three-phase, with full wave silicon diodes mounted on the rotating shaft and a surge suppressor connected in parallel with the field winding.
3. All insulation system components shall meet NEMA (MGI0221.40 and 16.40) standard temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 130ºC.
4. The main alternator and exciter insulation systems must be suitably impregnated for operation in severe environments for resistance to sand, salt, and sea spray.
5. A PMG excitation system shall derive excitation power from the main generator output.
6. Alternator should be capable of for 300% of the short circuit.
7. Regulator - A generator-mounted, volts-per-hertz-type exciter/regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be plus or minus 0.5% from no load to full rated load. Readily accessible voltage drop, voltage level, and voltage gain controls shall be provided. Voltage level adjustment shall be a minimum of plus or minus 5%. The solid-state regulator module shall be shock-mounted and epoxy-encapsulated for protection against vibration and atmospheric deterioration. Provide terminal box for generator and exciter leads. The regulator must be sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.

D. Cooling System:

1. Radiator - A radiator with blower type fan shall be sized to maintain safe operation at 50º C/122º F ambient temperature. The fan shall be capable of accommodating air flow restrictions external to the radiator/generator package of at least 0.5” H_20 ESP.
2. The engine cooling system shall be pre-treated by the engine supplier for the inhibition of internal corrosion.

E. Fuel System:

1. Natural Gas System:

    a. Carburetor.
    b. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
    c. Manual Fuel Shutoff Valves.
    d. Flexible Fuel Connectors.

e. Generator supplier to confirm provided fuel pressure and volume sufficient for generator set to operate under 100% load.

F. Ignition System

1. The ignition system shall be the low tension type and consist of magneto, transformers, and spark plugs. The magneto shall be of solid state design and spark plugs will incorporate gold palladium electrodes for reliability and life.

G. Automatic Starting System:

1. Starting Motor - A D.C. electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.
2. Automatic Control - Fully automatic generator set start-stop controls in the generator control panel shall be provided. Controls shall provide shutdowns for low oil pressure, high water temperature, overspeed, overcrank and one auxiliary contact for activating accessory items. Controls shall include 3 complete cranking attempts without overheating before cranking cycle is lockout.
3. Jacket Water Heater - A unit-mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 90º F. The heater shall be 208-Volts, single phase, 60 hertz. Vee-type engines of 12 cylinders or more shall have one heater per each bank of cylinders.
4. Batteries - A lead acid battery set of the heavy duty gas starting type shall be provided. Battery voltage shall be compatible with the starting system. The cold cranking amps as recommended by the engine manufacture necessary cables and clamps shall be provided.
5. Battery Boxes - Battery boxes shall be provided for each battery and shall conform to NEC 480.9. They shall be constructed and treated as to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil over battery electrolyte shall be contained within the box to prevent a direct path to the ground.
6. Battery Charger - A current limiting battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17-Volts per cell and equalize at 2.33-Volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120-Volts, single phase. Amperage output shall be not less than 5 amperes. Alarm contacts shall be provided for low voltage and battery charger failure. Charger shall be mounted in weatherproof enclosure adjacent to generator(s). Status for generator(s) shall be tied into building automation system.
7. Battery Heater- Battery heating system to be sized per manufacturer’s recommendation for battery system for cold climates. System to be controlled by locate thermostat. When temperatures fall below 18º C (65º F), the thermostat activates the battery heaters, maintaining optimum battery temperature. The thermostat turns the heater off at 27º C (80º F). AC input voltage shall be 120-Volts, single phase.

H. Weatherproof Generator Enclosure

1. Reinforced steel housing allowing access to engine, generator, radiator, and all other ancillary components.
2. Both sides will have motorized louvers sized for cooling and combustion air intake. Both sides of housing will have full height, double hinged access doors. Doors will have not less than two latching points, operable from the inside and outside, and equipped with keyed alike locks. All enclosure walls shall have sound attenuation to reduce dB level to 60 dB at 23 feet
3. Weather protective enclosure shall be equipped with a radiator discharge turning vane to redirect the radiator discharge air vertically.
4. Exhaust silencer shall be provided to meet the sound requirements of the specification. Flexible stainless steel connection shall be provided for each engine exhaust outlet connection to the silencer. Flex connection(s) shall be cable of isolating the exhaust silencer and building form the genset vibration. Mounting shall be provided by the Contractor. The silencer shall be mounted so that its weight is not supported by the engine, nor will the exhaust system growth, due to thermal expansion, be imposed on the engine. The exhaust back pressure shall not exceed manufacturers recommendations. Exhaust Silencer to be a extreme (50dBA) grade silencer.
5. Insulation - The muffler and all indoor exhaust piping shall be lagged by the manufacturer to maintain a surface temperature not to exceed 150º F. The insulation shall be installed so that it does not cover or interfere with the functioning of the flexible exhaust fitting
6. Heat – electric heat within enclosure to maintain 40F within the generator enclosure per NFPA 110-5.3.5. Include motorized louvers on intake and gravity louvers on discharge.
7. Manufacturer shall verify all clearances of combustion air intake and radiator discharge and provide additional louvers, turning vane, etc. as required to achieve the specified rating.

I. Main Line Circuit Breaker:

1. Type - A main line, insulated case circuit breaker with long time, short time and instantaneous trip features, mounted upon and sized to the output of the generator shall be installed as a load circuit-interrupting and protection device. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions. Generator breaker shall full coordinate with downstream devices and shall be included in coordination study.
2. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection provide with adjustments for long-term, short-term and instantaneous tripping. Provide ground fault alarm only where breaker is greater than 1000Amps. The circuit breaker shall meet standards established by Underwriters Laboratories, National Electrical Manufacturers Association, and National Electrical Code.
3. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.
4. Circuit breaker shall have battery voltage operated shunt trip wired to safety shutdowns to open the breaker in the event of engine failure.

J. Generator Control Panel:

1. Generator-mounted NEMA 1 enclosed solid state module for engine control and AC metering. Panel shall contain, but not be limited to the following equipment:

    a. Auto/Manual start-stop with LED indicators for low oil pressure, high coolant temperature, prealarm low pressure, prealarm high coolant temperature, low fuel, battery charger fault, low battery volts, low coolant temperature, not on auto, low coolant level, AC output fail over speed, over cranks and emergency stop. Safety shut-downs shall be automatic.
    b. Cyclic-cranking as specified by NFPA 110.
    c. Adjustable cool down timer (0-30 minutes).
    d. LCD readout for: engine oil pressure, coolant temperature, engine RPM, system DC volts, engine running hours, generator AC volts, generator AC amps and generator frequency.
    e. Engine control switch.
    f. Ammeter - Voltmeter phase selector switch.
    g. Emergency stop pushbutton.
    h. Indicator/display test switch.
    i. Voltage adjustment raise/lower switches.
    j. Auxiliary relay, 3PDT.
    k. Padlocking provisions.

2. Generator control panel shall be unit mounted and installed not more than 6’6” above the finished floor adjacent to the engine/generator set. Where control panel may be above the specified 6’6”, the Electrical Subcontractor shall provide a working platform adjacent to the engine/generator set which will allow proper access to maintenance personnel (control panel within 6’6” of platform). Provide catwalk if height condition cannot be met.
3. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Annunciator to have a minimum of 8 relays. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
4. Remote Emergency-Stop Switch: Comply with NEC 445.18(A) & (B) NFPA 110-5.6.5.6. Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation. Located outside of the enclosure.

K. Annunciator Panel:

1. Annunciator Panel – One panels shall be provided for remote mounting to give audible and visual warning of fault or alarm conditions in the generator set. In addition, panel shall have generator start/stop switch. The panel shall conform to requirements of the National Electrical Code, and the National Fire Protection Association publication

NFPA-110A. The panels shall be located adjacent to the Gondola Square fire alarm control panel.

L. Schedules:

1. In order to forecast and minimize engine failure, the supplier of the equipment must provide an oil sampling analysis kit which operating personnel shall utilize for scheduled oil sampling.
2. Scheduled oil sampling shall be accurate within a fraction of one part per million for the following elements:

    a. Iron
    b. Chromium
    c. Copper
    d. Aluminum
    e. Silicon
    f. Lead

3. The sample shall be tested for the presence of water, fuel dilution, and anti-freeze.

M. Generator Pad

1. Contractor shall provide a house keeping pad for the generator. Pad shall be a minimum of 3.5” high.
2. Confirm placement of anchor bolts and vibration isolators with manufacturers shop drawings.

N. System Service Contract:

1. The supplier of the standby power system must provide a copy and make available to the owner his standard service contract which, at the Owner’s option, may be accepted or refused. This contract will accompany any documents, drawings, catalog cuts, specification sheets, wiring or outline drawings, etc. submitted for approval to the designing engineer. The Contract shall be for the complete services rendered over a period of one year.

O. Temporary Generator Connection:

1. Load Bank Connection: Provide connection for temporary load bank with E1016 type camlock connectors. Provide load dump control method to remove load bank on loss of utility power.
2. Labeling: Provide permanent labeling on enclosure. Label shall include at a minimum the following:

    a. Voltage.
    b. Ampacity.
    c. Phase rotation.

d. Bonding requirements.
e. AIC rating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which gas engine-driven generator units are to be installed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF GAS ENGINE-DRIVEN GENERATOR SETS

A. Install gas engine-driven generator units in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.

B. Coordinate with other work, including raceways, electrical boxes and fittings, fuel piping and accessories, as necessary to interface installation of engine-generator equipment work with other work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening valves for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A, 486B, and the National Electrical Code.

D. Install units on vibration isolators in accordance with Division 23 section; and comply with manufacturer's indicated method of installation.

E. Connect fuel piping to alternative generator equipment as indicated and comply with manufacturer's installation instructions.

F. Align shafts of engine and generator within tolerances recommended by engine-generator unit manufacturer.

G. Generator set shall be capable of start-up and accepting rated load within ten (10) seconds to meet NFPA 110.

H. Provide all conduit and wiring from building panelboard to feed miscellaneous equipment such as jacket heaters, battery charger, etc.

I. Provide all control wiring for remote annunciation and controls.

3.3 GROUNDING

A. Provide equipment grounding connections for gas engine-driven generator units. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL

A. Start-up Testing:

1. Engage local equipment manufacturer's representative to perform start-up and building load tests upon completion of installation, with the Architect/Engineer in attendance; provide certified test record. Tests are to include the following:

    a. Check fuel supply, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
    b. Test prior to cranking engine for proper operation, accessories that normally function while the set is in a standby mode. Accessories include engine heaters, battery charger, generator strip heater, remote annunciator.
    c. Check, during start-up test mode, for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to line voltage and phase rotation.
    d. Test, by means of simulated power outage, automatic start-up, remote-automatic starting, transfer of load, and automatic shut-down. Prior to this test adjust for proper system coordination, transfer switch timers. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency

2. Perform a four-hour test with the following sequence:

    a. Two hours with building load or loads to simulate building load.
    b. Two hours 100% load of rating for generator.

    (Test results shall be documented and given to the engineer for review and approval.)

3. Upon completion of installation demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to Owner.

B. Simulated Power outage. Preform full building shut down and test of the optional power system. Test elevator recall function with transfer of power. Coordinate test with engineer and AHJ to witness the test.

3.5 MANUALS

A. In addition to the requirement of Section 26 05 00, provide 2 sets of complete manuals containing warranty, operational and maintenance instructions, recommendations for spare parts, routing servicing of the system, name, address, telephone number of factory authorized local service agency. One copy to be located in main electrical room and second with the generator.

B. Provide Preventive Maintenance Schedules as recommended by the manufacturer.

3.6 IDENTIFICATION

A. Provide identification nameplates for components as detailed in Section 26 05 53.

3.7 PERSONNEL TRAINING

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating gas engine-driven generator sets. In addition, train Owner's personnel in periodic maintenance of batteries. Provide one full day of training.

END OF SECTION 26 32 14

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

A. Extent of transfer switch work, including associated control devices, is indicated by drawings and schedules and as specified herein.

B. Types of transfer switches required for the project include the following:

1. Automatic transfer.

C. Refer to other Division 26 sections for wires/cables, electrical raceways, boxes and fittings, which are required in conjunction with transfer switch work; not work of this section.

D. Refer to Division 3 sections for concrete and grout work required in connection with transfer switch work; not work of this section.

E. Refer to Division 23 section for vibration control and isolation required in connection with transfer switches; not work of this section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s data and installation instructions for electrical power transfer switches.

B. Shop Drawings: Submit 1/2”=1’-0” scale layout drawings of electrical generator and transfer switches showing accurately scaled equipment locations, housekeeping pad size, location and spatial relationships to associated electrical equipment in proximity.

C. Wiring Diagrams: Submit wiring diagrams for electrical transfer switches, and associated control devices showing connections to prime and alternate power sources, electrical load, and equipment components. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of electrical power transfer switches, of types, rating, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing electrical power transfer switches similar to that required for this project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of electrical power transfer switches.
2. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches", and UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide transfer switches and components which are UL-listed and labeled.
3. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/No.'s ICS 2, "Industrial Control Devices, Controllers and Assemblies", ICS 6 and 250, pertaining to transfer switches.
4. NFPA Compliance: Comply with applicable requirements of NFPA 99; "Standard for Health Care Facilities", and NFPA 101; "Code for Safety to Life from Fire in Buildings and Structures", pertaining to transfer switches.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver transfer switches and associated devices in factory-fabricated type containers or wrappings, which properly protect equipment from damage.

B. Store transfer switches and associated devices in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle transfer switches and associated devices carefully to prevent physical damage to equipment. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

PART 2 - PRODUCTS

2.1 TRANSFER SWITCHES

A. General: Except as otherwise indicated, provide manufacturer's standard design, materials and components as indicated by published product information, designed and constructed as recommended by manufacturer for duty indicated, and as required for a complete installation.

B. Automatic Transfer Switches shall be provided with 4 poles (as indicated on the drawings), current ratings as indicated on the drawings, for a normal and emergency source of 480-Volts, 3 phase, 4 wire, 60Hz with neutral bus. The transfer switch shall be braced to have a short circuit rating as indicated on the drawings. The transfer switches shall be listed per UL Standard 1008 as a recognized component for emergency systems and rated for total system load. The pickup voltage shall be adjustable from 85% to 98% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value.

C. The automatic transfer switches shall be mechanically held, electrically operated type and suitable for continuous duty in an unventilated sheet metal enclosure without derating (NEMA Type A IEC Type PC). The transfer switches shall be inherently double throw so both sets of contacts move simultaneously when the switch is transferring.

D. Delay Transition: The transfer switches shall be mechanically interlocked to ensure only three possible positions-normal, neutral and emergency. Delay transfer switches shall be provided for all standby transfer switches.

E. All main contacts shall be silver alloy wiping action type. They shall be protected by arcing contacts in sizes above 400 amperes.

F. All switch and relay contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panels from the enclosure and without disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous duty industrial control type with minimum contact rating of 10 amperes.

G. Automatic transfer switches utilizing components of molded case circuit breakers, circuit interrupters, disconnect switches, or parts thereof which had not been intended for repetitive switching are not acceptable. An overload or short-circuit shall not cause the transfer switch to go into neutral position.

H. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0.5 to 15 seconds and factory set at 3 seconds.

I. The switch shall transfer the load to the emergency power system after the generator set reaches proper voltage and frequency. Time delay transfer to emergency power adjustable from 0 to 120 seconds (set at 5 seconds) shall allow the engine-generator set to stabilize before application of load.

J. A time delay on retransfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and factory set at 15 minutes.

K. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 98% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal.

L. Transfer switch shall be factory equipped with a means to prevent large inrush currents due to transfer between energized sources. This feature shall provide a field adjustable time delay during switching in both directions, during which time the load is isolated from both power sources, to allow residual voltage of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. The programmed transition feature shall have an adjustable time range of 0 to 7.5 seconds. All transfer switched specified to be supplied without programmed transition shall be capable of addition of the programmed transition feature in the field without transfer switch replacement. Transfer methods that use the phase relationships between the two power sources to control a transfer initiation time are not acceptable.

M. A contact that closes when normal source fails for initiating engine starting, rated 10 amps, 32-Volt D.D. Contacts to be gold plated for low-voltage service.

N. Pilot lights to show switch position.

O. Two set of normally open and one set of normally closed auxiliary contacts.

P. A test switch to momentarily simulate normal source failure.

Q. Harnessing between transfer switch and control panel shall have built-in disconnect for routine maintenance.

R. Transfer switch shall be furnished with an operator’s manual providing installation and operating instructions.

S. Transfer switch shall be supplied in a NEMA 1 enclosure.

T. Transfer switch shall be furnished with an adjustable exerciser circuit. Selectable exercise time of the day of month, time of day, and duration shall be provided.

U. The control module shall direct the operation of the transfer switch. The module’s sensing and logic shall be a built-in microprocessor-based system for maximum reliability, minimum maintenance, and inherent digital communications capability. The control settings shall be stored in nonvolatile EEPROM. The module shall contain an integral programmable clock and calendar. The control module shall have a keyed disconnect plug to enable the control module to be disconnected from the transfer mechanism for routine maintenance. The control module shall be mounted separately from the transfer mechanism unit for safety and ease of maintenance. Interfacing relays shall be industrial control grade plug-in type with dust cover.

V. The control module shall include programming keypad, alpha-numeric display for monitoring settings and diagnostic values, key-lockable program selector switch, light-emitting diode status indications, and user instructions. These features shall be user accessible when the enclosure door is closed.

W. The control module shall be capable of storing the following records in memory for access either locally (at the control module) or remotely (at a computer):

1. Number of hours transfer switch is in the emergency position (total and since record reset).
2. Number of hours the emergency is available (total and since record reset).
3. Total transfers in either direction (total and since record reset).
4. Date of record reset.
5. Date of last exercise period.
6. Date, time, and description of the last four source failures.
7. Elapsed time during the most recent source outage.

X. Provide permanent label indicating maximum available fault current at the transfer switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which transfer switches are to be installed and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TRANSFER SWITCHES

A. Install transfer switches, including associated control devices as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that transfer switches comply with requirements. Comply with applicable requirements of NEC and NFPA pertaining to wiring practices and installation of electrical power transfer switches.

B. Coordinate with other electrical work, including raceway, and electrical boxes and fittings, as necessary to interface installation of transfer switch work with other work.

C. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are no indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B.

D. Provide in conjunction with each and every automatic transfer switch the following:

1. 2# 12-1"C from auxiliary contact (closed when switch in emergency position) on transfer switch to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.

2. 2# 12-1”C from auxiliary contact (closed before switch returns to normal power) on transfer switch serving elevators to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
3. 2# 12-1”C from engine start contact on transfer switch to respective emergency generator control panel and remote annunciator panels with start and stop controls.
4. 2# 12-1”C from auxiliary contacts on fire pump controller for generator start.
5. Wiring as necessary from transfer switch to remote annunciator panels and engine control panel for transfer switch position indicator lights.
6. All generator control wiring shall be routed in a 2-hour rated enclosure.

E. Provide all necessary wiring and conduit to each remote alarm panel located in the IT Data Center. An additional annunciator panel shall be located adjacent to the Gondola Square Fire Alarm Control Panel.

3.3 GROUNDING

A. Provide equipment grounding connections for transfer switch units as indicated. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL

A. Test transfer switches, by means of simulated power outage; automatic start-up by remote-automatic starting, transfer of load and automatic shutdown. Prior to these tests, adjust transfer switch timers for proper system coordination.

B. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of transfer switches with requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting, where necessary, at no cost to Owner.

3.5 PERSONNEL TRAINING

A. Building Operating Personnel Training: Train Owner’s building personnel in procedures for starting-up, testing and operating transfer switches and auxiliary equipment.

END OF SECTION 26 36 23

SECTION 26 90 00 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:

1. Copies of all warranties
2. Operation & Maintenance Manuals
3. Required tests
4. Certifications
5. Record drawings
6. Permit requirements

B. The contractor shall compile a closeout manual which shall include:

1. A list of all required tests and a place for signoff of date completed.
2. A list of all submittals with dates of acceptance by the engineer.
3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
4. Test procedures to be used for optional systems.
5. Project close out check list.

C. The final closeout manual shall include the following:

1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
3. Copies of all warranties.

D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:

1. A list of all required tests.
2. Preliminary schedule showing major milestones for completion of the electrical and technology systems.

B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.

C. Within 2 weeks of substantial completion submit a completed “Project Closeout Check List”, and the Final Closeout Manual.

D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary - Electrical

☐ The following tests have been completed. Submit test report for record.

- ☐ Feeder Testing and Reporting (Megger Result)
- ☐ Transformers Testing and Reporting
- ☐ Grounding System Testing and Reporting
- ☐ Generator Testing and Reporting
- ☐ Infrared Scans, Testing and Reporting

☐ All main components of the electrical system cleaned and vacuumed. This includes unit substations, switchboards, distribution boards, panel boards, etc. Provide ME Engineers with schedule when this is going to occur and a letter stating it has been completed.

☐ The contractor shall schedule a walk through with the engineer to inspect all feeder sizes. Covers for panel boards and distribution boards should be removed by the contractor for visual inspection of feeder sizes.

☐ The fire alarm system manufacturer shall provide the Owner/Architect with a “Letter of Certification” indicating the system is fully functional and meets all manufacturers requirements as well as code and design requirements. Fire department must sign off the system.

☐ Provide spare fuses and fuse cabinets ((1) in each switch gear room) per specifications.

☐ Panelboard directories completed with typed print outs.

☐ Record drawings submitted.

☐ All lighting control systems complete with controls fully operational for visual inspections.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

A. Prior to completion and punch list by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 OPTIONAL STANDBY SYSTEMS

A. All optional standby systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official.

B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.

C. Once tested by the contractor and fully operation the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

3.3 COORDINATION WITH OTHERS

A. The Division 26 contractor shall coordinate their requirements with the general contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 26, 27 and 28 systems.

3.4 PUNCH LISTS

A. The contractor shall submit in writing that the project is ready for final review by the engineer.

B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.

C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.

D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION 26 90 00

APPENDIX A
Fixture Cuts

STEAMBOAT BASE AREA

me engineers

Job Number:
DV20131

Issue Description:
IT ENABLING PACKAGE

Issue Date:
2/5/2021

LED Fixtures

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — The CLX is a linear lighting solution that is available in multiple lengths, lumen packages and distributions. Designed for versatility, the CLX can address virtually any indoor lighting need. The CLX is also offered in standard and high efficacy configurations and capable of being continuous row mounted or installed as a stand-alone fixture. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Channel and cover are formed from code-gauge cold-rolled steel. Housing and lens endcaps are injection molded plastic to provide a more architectural look and feel. The endcaps come standard with a 7/8" knock out for continuous mounting but can be ordered without.

Finish: Paint options include high-gloss, baked white polyester (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). Five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Offered with acrylic lens and less lens configurations. Provides a choice of optical distributions including, wide, narrow, and aisle.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 14.) Electronic LED driver is multi-volt input and 0-10V dimming standard (see Operational Data on page 12 for actual wattage consumption). This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

L70>100,000 hours at 25˚C.

LEDs provide nominal 80 CRI or 90CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,500 lumens per foot.

INSTALLATION — Fixture may be ceiling or wall mounted (with or without THCLX hanger or angle mounted with CLXANGBRT), pendant or stem mounted with appropriate mounting options.

WARNING — Removing the lens and opening the fixture during installation exposes the LEDs, putting them at risk for damage.

If you plan to surface mount the fixture, we recommend using the THCLX. This eliminates the need to open the fixture.

If you plan to continuous row mount, we recommend using the PLR wiring harness option. This eliminates the need to open the fixture.

Damage to the LEDs caused during installation will not be covered under the warranty.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -4°F (-20°C) and 104°F (40°C). Optional High Ambient (HA) ranging to 122°F(50°C) available on certain lumen packages (See ambient temperature chart for additional information).
DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Stock configurations are offered for shorter lead times:

Stock Part Number	UPC	DLC QPL Product ID	DLC Premium
CLX L48 3000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525816	PJANKZR4	Yes
CLX L48 3000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525885	PKW32VKL	Yes
CLX L48 5000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525939	P77I8Z20	Yes
CLX L48 5000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525908	P8A42C1H	Yes
CLX L96 6000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525861	PPFTGRBV	Yes
CLX L96 6000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525915	PW6250TE	Yes
CLX L96 10000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525922	PYKOC7EW	Yes
CLX L96 10000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525830	PKYPL35K	Yes
CLX L48 3000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525960	PJANKZR4	Yes
CLX L48 3000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525892	PKW32VKL	Yes
CLX L48 5000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525854	P77I8Z20	Yes
CLX L48 5000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525946	P8A42C1H	Yes
CLX L96 6000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525878	PPFTGRBV	Yes
CLX L96 6000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525823	PD0SSIAD	Yes
CLX L96 10000LM SEF RDL MVOLT GZ10 40K 80CR WH	00191723525953	PYKOC7EW	Yes
CLX L96 10000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525847	PKYPL35K	Yes

LED Linear

CLX

24", 36", 48" and 96" Lengths

Flat Diffuse Lens

Round Diffuse Lens

Wide Diffuse Lens

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

CLX LED Linear

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example:** CLX L48 5000LM SEF WDL MVOLT GZ10 40K 80CRI WH

Series	Length	Nominal lumens	Performance package	Louver	Lens
CLX LED linear	L24 24"[1,2]	1500LM 1,500 lumens 2000LM 2,000 lumens 2500LM 2,500 lumens 3500LM 3,500 lumens 4500LM 4,500 lumens 5000LM 5,000 lumens[3,4]	SEF Standard efficiency[5] HEF Premium efficiency	(Blank) Less louver SBLW Straight blade louver, white[6] SBLMB Straight blade louver, matte black[6] SBLGV Straight blade louver, galvanized[6] SBLSKGY Straight blade louver, smoke gray[6]	L/Lens Less lens FDL Flat diffuse[7,8] RDL Round diffuse[7,8] WDL Wide diffuse[7,8]
	L36 36"[2]	2250LM 2,250 lumens 3000LM 3,000 lumens 3750LM 3,750 lumens 5250LM 5,250 lumens 6750LM 6,750 lumens 7500LM 7,500 lumens[3,4]			
	L48 48"	3000LM 3,000 lumens 4000LM 4,000 lumens 5000LM 5,000 lumens 7000LM 7,000 lumens[2] 9000LM 9,000 lumens[2] 10000LM 10,000 lumens[2,4]			
	L96 96"	6000LM 6,000 lumens 8000LM 8,000 lumens 10000LM 10,000 lumens 14000LM 14,000 lumens[2,4] 18000LM 18,000 lumens[2,4] 20000LM 20,000 lumens[2,4]			

Distribution	Voltage	Driver[14]	Color temperature	Coloring rendering index
(Blank) General ND Narrow[8,9] WD Wide[8,9] AD2 Aisle, 24° off center[8,9]	MVOLT 120-277V[10] 120 120V 208 208V[11] 240 240V[11] 277 277V 347 347V[12,13] 480 480V[12,13]	GZ10 0-10V dimming[15] EZ1 Dimming to 1%[2]	30K 3000 K 35K 3500 K 40K 4000 K 50K 5000 K	80CRI 80 CRI 90CRI 90 CRI

Options

PS1050	Emergency battery pack, 10W, CA Title 20 Noncompliant[2,11,13,16,17]
E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[2,11,13,16,17]
BGTD	Generator transfer device, not avaialble with PS1050[13,16,18]
OCS	5', 18/3 Reloc selectable One Pass cable[16]
HA	High ambient, for use in ambient temperatures up to 50°C[11]
EPNKO	Decorative endplate, no knock out[19]
OUTCTR	Wiring leads pulled through back center of fixture[20]
OUTEND	Wiring leads pulled through end of fixture[21]
Cord Sets:	
CS1W	Staight blade plug, 120V[10,16]
CS3W	NEMA twist-lock plug, 120V[10,16]
CS7W	Staight blade plug, 277V[10,16]
CS11W	NEMA twist-lock plug, 277V[10,16]
CS25W	NEMA twist-lock plug, 347V[10,16]
CS97W	NEMA twist-lock plug, 480V[10,16]
CS93W	600V SEOOW white cord, no plug (no voltage required)
CS6WG16ST0WD5D	6' white cord, 16/5, no plug, includes low voltage dimming wires (no voltage required)[15]
PLR___	Plug-in wiring, see page 16 for ordering information
PLR1LVG	Plug-in wiring,low voltage dimming[22]
RRL___	RELOC®-ready luminaire. See page 15 for ordering information
SPD	Surge protection device, provides up to 6kV protection[29]
USPOM	Assembled in the United States
nLight® Wireless:[23,24]	
NLTAIR2 RES7	nLight® Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell
NLTAIR2 RES7PDT	nLight AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell
NLTAIR2 RIO	No sensor control
nLight® Wired:[23,25]	
N100	nLight® without lumen management
NES7	nLight® nES 7 PIR integral occupancy sensor[26]
NESPDT7	nLight® nES PDT 7 dual technology integral occupancy control[26]
NES7ADCX	nLight® nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell[26]
NESPDT7ADCX	nLight® nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell[26]
Individual controls:[23,25]	
MSD7	PIR integral occupancy sensor
MSDPDT7	PDT 7 dual technology integral occupancy control
MSD7ADC	PIR integral occupancy sensor with automatic dimming control photocell
MSDPDT7ADC	PDT integral occupancy sensor with automatic dimming control photocell

Finish

WH	White
GALVW	Galvanized with white lens end caps
GALVB	Galvanized with black lens end caps
MB	Matte black
SKGYW	Smoke gray with white lens end caps
SKGYB	Smoke gray with black lens end caps

See Accessories and footnotes on next page

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE

Provides years of maintenance-free illumination for indoor or outdoor use in residential & commercial applications.

CONSTRUCTION

Cast-aluminum housing with corrosion-resistant paint in an industrial grey finish.

Sealed gasket protects against moisture and dust.

OPTICS

4000K CCT LEDs.

Frosted glass diffuser provides even light distribution.

LUMEN MAINTENANCE

LEDs will deliver 70% of their initial lumens at 50,000 hour average LED life. See Lighting Facts label on page 2 for performance details.

ELECTRICAL

MVOLT driver operates on any line voltage from 120-277V

Operating temperature -40 C to 40 C.

4kV surge protection standard.

INSTALLATION

Mounts to ceiling or wall with surface mount junction box (included).

LISTINGS

UL Listed to U.S. and Canadian safety standards for wet locations.

Tested in accordance with IESNA LM-79 and LM-80 standards.

WARRANTY

Five-year limited warranty. Full warranty terms located at www.AcuityBrands.com/CustomerResources/Terms_and_Conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications are subject to change without notice.

Outdoor General Purpose

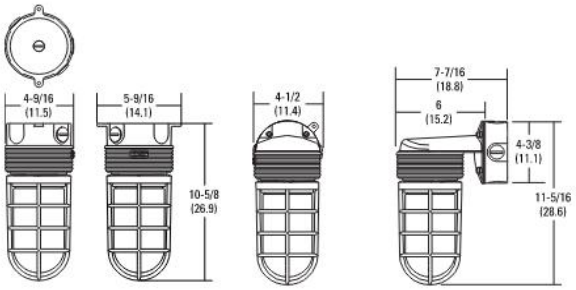
OLVTCM & OLVTWM

LED VAPORTIGHT

LED

Specifications

All dimensions are inches (centimeters)



ORDERING INFORMATION For shortest lead times, configure products using **bolded options**. **Example:** OLVTCM

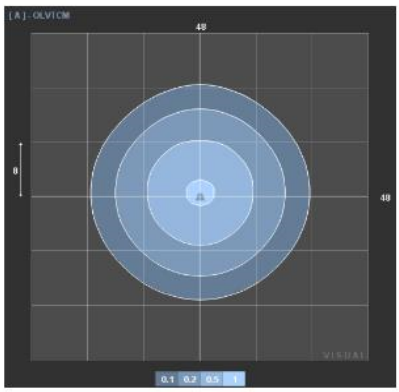
Series	Color temperature	Voltage	Finish
OLVTCM Ceiling MT **OLVTWM** Wall MT	**(blank)** 4000K	**(blank)** MVOLT (120V-277V)	**(blank)** Grey

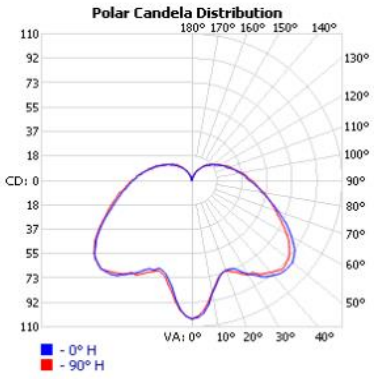
Series	System Wattange	Lumens
OLVTCM	15W	600
OLVTWM	15W	600

PHOTOMETRICS

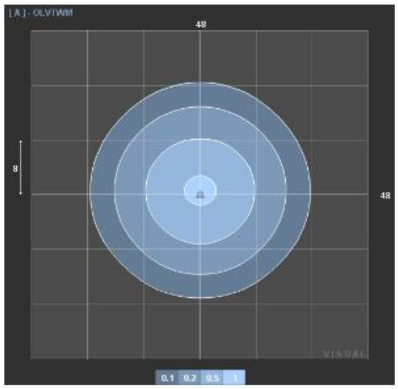
To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's Outdoor LED homepage
Tested in accordance with IESNA LM-79 and LM-80 standards.

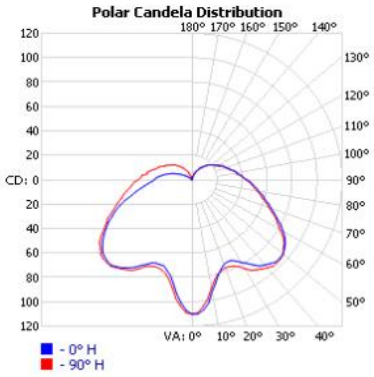
OLVTCM





OLVTWM





SECTION 27 00 00 - TECHNOLOGY SYSTEMS

A. General: The primary objective shall be to establish a new Communications Data Center and the reestablishing the interconnections necessary for continuous operations. Design and installation shall comply with all appropriate building codes and industry standards including but not limited to ANSI/EIA/TIA, BICSI, NEC, NEMA, and IEEE, etc.

B. Communications Infrastructure

1. Comm Rooms: Communications rooms shall include both existing and new dedicated comm rooms. These shall include a new Main Telecommunications Room (MTR), existing Telecommunication Rooms (TRs), and existing Wireless Equipment Room (WER). TRs will co-locate tele/data, security, distributed sound, and other low voltage systems and equipment.

   Provided below is a summary of telecommunication room requirements.

   a. Main Telecommunications Room

      1) Location = Gondola Square – Garage North - Level-01

         a) North wall, garage corner, along Sheraton shared wall and adjacent to existing AT&T DAS wall.
         b) Data Center Size = ~316sf
         c) Vendor Rm Size = ~48sf

      2) Flooring: Static-Control Coating

         a) Multi-layer, vulcanized conductive rubber

            (1) Meets or exceeds all ESD controls standards by ASTM F-150, NFPA 99, ANSI/ESD S7.1-2005 and UL 779

      3) IT Equipment Cabinets = (6) @24x42x84 4-post enclosure + (1) Fiber termination rack.

         a) TrippLite – 42U enclosed equipment cabinet
         b) Vertical and horizontal PDUs.

      4) Vendor Racks = (1) @19x84 2-post racks + Backboard Wall Field
      5) Backboard = 0.75-inch plywood (fire resistant, AC-grade) painted white and mounted on end wall and one long wall in Vendor room and Data Center.
      6) Cable Tray = 12-inch around Data Center perimeter and above rack/cabinet rows.
      7) Cooling/Heating = Primary + Redundant CRAC Units (n+1) in IT rack room. Power for all units to be connected to generator. Dedicated

thermostat shall be provided within each room. Locate condensing units on exterior concrete pad near generator.

a) (2) split systems for IT rack room,

8) Power Metering = 30 day minimum metering report for existing panel feeding IT room when building is under normal operation. Existing loads will need to be metered to size new electrical distribution equipment serving this space.
9) Power = 50 kVA IT equipment load. Power to be connected to rack mounted UPS and generator.

a) Provide 75 kVA transformer feeding a 208Y/120V dedicated 250A panel board located within the new IT room or adjacent workroom. Panel will be fed from a new natural gas generator located adjacent to the Gondola Plaza Utility Transformer via Automatic Transfer Switch. The natural gas service to this generator is intended to be from the surveyed gas line along Mt. Werner Circle.
b) Track busway above racks with bus-plug receptacles at Racks and Cabinets.
c) Dedicated receptacles on walls at 10’ O.C. around perimeter of room.

10) UPS = Primary Unit 50kVA of IT equipment load and 30-minute runtime.
11) Emergency Power-Off Switches: Provide two EPO switched located at room entrance for powering down (1) all normal, emergency (or stand-by) power and UPS equipment and (2) all mechanical equipment serving the IT room. EPO switches shall be interfaced to fire alarm/suppression system for automatic shut-off or manual activation by Operator.
12) Telecom Ground = TMGB
13) Fire Suppression = Clean Agent, NOVEC 1230.
14) Plumbing: Under no conditions shall any pressurized water piping be routed through this room. Additionally, any gravity piping such as waste lines and roof drain lines should not be routed through this room, however; if it is not possible to meet this condition then drip pans with drain lines shall be provided below all piping or a waterproof membrane installed above entire room complete with perimeter drain system.
15) Patch Cords: Quantity TBD, SMFO, MMFO, Cat6, 3’,6’,10’ + Rack fibers
16) Supports:

- Telecom Utility Demarc, Cross-Connects, and Equipment
- Telecom Backbone Main Cross-Connect
- Optical Fiber Back-Bone Main Cross-Connect
- Tele/Data Horizontal Cross-Connect
- Data/LAN Core Switches
- Servers
- IPTV Head-End

b. Telecommunications Rooms (TRs)

1) Existing to Remain:

a) Building A
b) Building B (re-build)
c) Building F
d) Promenade Bldg (future)

c. Wireless Equipment Room (WER)

1) Existing to Remain:

a) Gondola Square – Garage North - Level-01, under Gold Run Walk

2. Utilities Infrastructure: The campus utilizes two service entrances to support voice, data, internet, television, and broadcast video transport, etc. The primary service is based on the Gondola fiber from the mountain peak. The secondary entrance is the existing point of presence in the Gondola Square Garage North, along the east wall, mid-garage in a shared space with Mechanical and Steam equipment.
3. Building Infrastructure: With the relocation of the Main Communications Room from the Gondola Building to the Gondola Square Garage North (optional location A/B), the communications building infrastructure system shall be rebuilt to support voice and data applications/systems using a structured cabling system including fiber optics and twisted pair copper. Primary backbone cable including optical fiber (SM2) and telecom (Cat. 3) cables shall route from the new MTR to each TR and remote unit using a physical star topology. Horizontal station cable shall be covered in subsequent designs and shall then consist of Cat. 6A capable of supporting 10Gbps or higher cables to support telephone, data, Wi-Fi, IPTV (television), security cameras, point of sale (POS), internet, and other tele/data and IP enabled applications.

The following is a summary of general device and program requirements.

a. Backbone Interconnects (all originating at the MTR):

1)	Bldg A TR:	24-SMFO, (1) 25Cat3
2)	Bldg B TR:	24-SMFO, (1) 25Cat3
3)	Bldg C TR	(1) 25Cat3
4)	Bldg D TR	(1) 25Cat3
5)	Bldg E TR	(1) 25Cat3
6)	Bldg F TR	(1) 25Cat3
7)	Gondola Tower 3:	96-SMFO
8)	Timber & Torch:	24-SMFO
9)	MTC:	48-SMFO (Spice in HH to ex Christy 6 fiber)
10)	OSP:	24-MMFO, (2) 25Cat3 (Splice in ex PB)
11)	Wild Horse Lift House:	24-SMFO, (1) 25Cat3 (Splice in ex PB)

12) AT&T: 48-SMFO
13) EX Service Entrance: (2) 50Cat3

b. Backbone Interconnects (all originating at the Vendor Room):

1) AT&T: 24-SMFO

C. Systems

1. Information Technology (IT) Systems: Steamboat IT will determine which existing IT systems (servers, switches, etc) will be relocated from the existing Data Center and which will be fully replaced new. Contractor shall assume rack and stack for all (6) existing IT racks within the existing data center, as part of this scope.
2. Wireless Communications: An existing complete and fully functioning distributed antenna system (DAS) is installed on site today. The project includes fiber considerations to maintain operation of the existing system, as described above.
3. Wireless 2-Way Communications: An existing complete and fully functioning 2-Way radio system is installed on site today. A radio rack installed on the 4th floor of the Gondola Building shall be relocated to 5th floor of building A. The existing exterior antenna shall be uninstalled and installed new on the roof of Building A.
4. Security Systems: The existing security systems on site include building by building security control panels that are networked for access control as well as CCTV cameras connected to local networked DVRs. The separation of the security system does not require special attention as part of this project. The head-end server/user work station will be relocated with the security office as part of the move-out process.

END OF SECTION 27 00 00

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendixes: Refer to Appendix 1, Equipment Schedules within each specification section for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals but are not intended to be an all-encompassing bill of materials.

B. Part 1 and Part 3 of this specification applies to all Division 27 specification sections.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

F. Rough carpentry is specified in a Division 6 section.

1.2 SUMMARY

A. Project Expectations: **Within one week after award of contract, the Contractor shall arrange a "CA kickoff" meeting and/or conference call with the General Contractor, Construction Manager, Architect, Engineer, and Owner (when applicable) to discuss general project expectations.**

B. The term "provide" used throughout this specification and drawings shall mean "furnish, install, test, and certify".

C. Coordinate project schedule, installation schedule, phasing and any other requirements deemed necessary with Construction Manager and/or General Contractor and all necessary trades to ensure successful completion of work.

D. Phasing, temporary distribution/equipment, cut-over and implementation as called out within the plans, shall be coordinated with Owner, Construction Manager and/or General Contractor, Architect, and Engineer prior to execution.

E. Extent of communications infrastructure work is indicated by Division 27 specifications and Technology drawings and schedules and is hereby defined to include, but not by way of limitation, the provisions of:

1. Raceway systems including but not limited to conduits, sleeves, telecommunication services entrance, manholes, pull-boxes, junction boxes, back-boxes, etc. as required and specified in Division 27 sections and/or select Division 26 sections. The Construction Manager and/or General Contractor shall coordinate this with the Sub-Contractor performing work and determine how scope of work is assigned. The purpose of this specification is to establish design intent and general system scope.
2. All communications infrastructure shall be provided as part of the Project including but not limited to raceway, cable, cable terminals, and comm room fit-out.
3. Backbone cables between the Main Cross-connect (MC) and each Intermediate Cross-connect (IC) or Remote Hub location. Refer to Technology Drawings (one-lines and floor plans) for specific locations and sizes.
4. Horizontal or station cables between each communication device outlet and the nearest Intermediate Cross-connect (IC) location.
5. Backbone and horizontal cable termination and terminals including but not limited to wiring panels/blocks, patch panels, fiber optic terminals and panels, and outlets/jacks.
6. Patch cords, jumper cables, and cross-connect cables to interconnect wiring terminals as well as electronic equipment.
7. Communication room hardware and component fit-out including cabinets, racks, cable tray, backboard, and raceways for terminating cable and installation of electronic equipment.
8. Power distribution within equipment racks and cabinets including power strips.
9. Grounding and bonding of all metallic hardware components to the nearest telecommunications grounding bus (TGB) bar including but not limited to equipment racks, cabinets, cable trays, ladder rack, metallic cable sheaths, wall mounted wiring terminals, conduits, sleeves, metallic ductwork, and frames.
10. All physical cable management hardware including, but not limited to: “J-hooks” in accessible ceiling areas, “D-rings” on backboards, vertical and horizontal managers on racks and cabinets, vertical and horizontal ladder-type or wire basket cable tray within communication rooms, etc.
11. Fire stopping as required. Contractor shall provide fire stopping for all low-voltage openings (including empty low voltage raceway) once cable installation is complete. Confirm specific fire stopping scope requirements with General Contractor and/or Construction Manager.
12. Testing of all communications cable infrastructure and grounding systems as noted by specification, drawings, and applicable industry standards.
13. Labeling of all communication infrastructure components, hardware, cable, and terminations with mechanically printed labels.
14. Preparation and submission of product data, shop drawings, testing reports, as-built drawings, and cabling documentation as required in this specification.
15. Construction and Installation warranties.
16. Manufacturer components, channel and solutions warranties.
17. Installation and testing of all system and components.

18. Onsite administrative and user training.
19. Manufacturer training of components.

1.3 SUBMITTALS

A. General Description and Requirements

1. Refer to Product Data and Shop Drawing Submission Checklist (appendix) at the end of this specification section for additional requirements specific to each Division 27 section.
2. Contractor shall not submit product data for review without submitting corresponding shop drawings as part of the same submittal package. Partial submittals will be returned as “revise and resubmit”.
3. Submittal Schedule:

    a. Within (1) week after award of contract, the Contractor shall submit a proposed schedule for submitting product data and shop drawings. At a minimum, the following items shall be included:

        1) Submittal date for Compliance Matrix.
        2) Submittal date for Construction Schedule.
        3) Submittal date for Product Data and Shop Drawings.
        4) Submittal date for Commissioning and/or Test Results.
        5) Submittal date for As-Builts.

    b. Within **15** days after award of contract or as dictated by the construction schedule (whichever period of time is shorter), the Contractor shall submit prefabrication submittals consisting of product data and shop drawings for approval. Partial submittals will not be accepted without prior written approval from the Architect.

4. In addition to the requirements noted herein, refer to Division 1 Specification for additional requirements. As a minimum, Contractor shall ensure all requirements listed here are met.
5. Review of the Prefabrication Submittals by the Architect and Engineer is for purposes of tracking the work and contract administration and does not relieve the Contractor of responsibility for any deviation from the Contract Documents, or from providing equipment and/or services required by the Contract Documents which were omitted from the prefabrication submittals.
6. No portion of the project shall commence nor shall any equipment be procured until the prefabrication submittals (including product data and shop drawings) have been approved in writing by the Architect. All installations shall be in accordance with the Contract Documents.
7. A detailed completion schedule shall be submitted with the prefabrication submittals.
8. Prefabrication submittals shall be accompanied by a letter of transmittal identifying the name of the project, Contractor's name, date submitted for review, and a list of items transmitted.

B. Compliance Matrix:

1. Compliance Matrix: Provide a specification compliance matrix indicating compliance or deviation for each item in the specification. Refer to the SPECIFICATION RESPONSE section within this specification and Appendix 2 for additional requirements.

C. Product Data:

1. Warranty Information: Provide all warranty information as described in this specification section for review and approval.
2. Component List: Provide complete submittal component list (i.e. table of contents) at the beginning of the submittal package. Component list and manufacturer cut-sheets shall be compiled to match the order of each Appendix. Component list shall include:

    a. Component name
    b. Manufacturer
    c. Specific product number (to clearly indicate special options, colors, etc.)

3. Cut-Sheets: Submit manufacturer's cut-sheets on all components listed within this specification and corresponding appendix. All components and parts being used shall be highlighted in color on cut-sheets to distinguish specific product/part numbers, options, colors, accessories, etc.
4. Product Substitutions: These specifications are intended to be performance based, thus all products listed in each respective Appendix 1: Equipment Schedules are "benchmark" products. The Contractor may submit (as a proposed alternate solution) substitute manufacturers and models that may be more cost effective or readily available. All substitutions shall meet or exceed the minimum functional, physical, and technical specifications. Acceptance of such substitutions is at the discretion of the Owner, Architect, and Engineer. Additionally, the requirements of Division 1 Specifications shall apply and may supersede requirements noted herein.

D. Prefabrication Shop Drawings: (Refer to Appendix-3 for additional requirements)

1. General: All shop drawings shall be provided on contractor specific title block. Contractor may use Technology Drawing files as a "starting point" for shop drawings but additional information shall be added and/or updated as noted below.
2. Symbol Legend, Abbreviations, and Description: Drawings shall include the following:

    a. General project information, contractor company name, etc.
    b. Descriptions of all abbreviations and symbols
    c. Typical device mounting heights
    d. General notes and/or scope description, exclusions, etc.

3. One-Line Wiring Diagrams: Provide backbone raceway one-line, backbone and horizontal cabling, copper pair and fiber strand counts, cable quantities, splice enclosures, etc. Include conduit allocation and fill ratios for all conduits on the raceway one-line diagram.

4. Site Plan: Provide complete site and exterior plans indicating all site and building façade mounted communication device outlets, equipment, and components proposed to be installed. Additionally, manholes, pull-boxes, and all major raceway routing shall be indicated for conduits 2-inches and larger. Shop drawings shall represent final conduit routing and manhole and/or pull-box placement as coordinated and/or confirmed with Service Provider, Civil Engineer and other trades.
5. Enlarged Plans:
    a. Provide ¼" = 1'-0" enlarged plans of all communication rooms (as applicable) indicating the position of equipment cabinets and/or racks, wiring terminals, patch panels, grounding equipment, cable tray, fiber and copper terminations, and other low voltage systems equipment layout within the rooms.
    b. Shop drawings shall clearly indicate final conduit/riser (core drill and/or block-out) locations and sizes as coordinated and/or confirmed with Structural Engineer and any field conditions that impact proposed location.
    c. Shop drawings shall clearly indicate areas where equipment clearances may be limited, for review and approval by Owner, Architect, and Engineer.
6. Details: Document method of attachment of racks to the floor and ladder tray systems, method of attachment of wall mounted distribution frames, grounding details indicating grounding method for cabinets, racks, cable tray, cable management, and power details for rack mounted power distribution.
7. Elevations:
    a. Rack elevations (produced in Visio, ACAD, or similar) indicating exact placement of patch panels, fiber terminals and enclosures, vertical and horizontal cable managers, rack mounted power strips or distribution units, empty rack-units, etc.
    b. Wall elevations shall detail any and all known components to be mounted on the walls, whether those items are provided by Contractor producing shop drawings or not. Components shall include, but not be limited to, electrical and/or fire alarm panels, security panels, distributed antenna system (DAS), CATV, communication infrastructure distribution frames with block size, cable routing, cable management, pair counts, method of attachment, etc.
8. Drawing Scale: Shop drawings shall be drawn to scale and completely dimensioned as to clearly show construction detail.
9. Labeling: Provide documentation of all labeling schemes for conduit, back-boxes, cables, outlets, wiring blocks and/or patch panels, device faceplates, etc.
10. Documentation: Provide submittals and documentation as required by the project manual (in addition to electronic copies) for review or as indicated in Division 1 general conditions.

E. Record As-Built Drawings:

1. All record as-built drawings shall be provided on contractor specific title block. Contractor may use Technology Drawing files and/or shop drawings as a "starting point" for as-built drawings. As-built drawings shall comply with shop drawing requirements

above, but shall be updated to align with actual installation. Additionally, area plan drawings shall indicate all device labeling including, but not limited to, tele/data port labels.

1.4 QUALITY ASSURANCE

A. Codes and Standards: All materials and installations shall comply with current applicable codes and standards, including but not limited to:

1. TIA-526: Standard Test Procedures for Fiber Optic Systems.
2. TIA-568-C.0: Generic Communications Cabling for Customer Premises.
3. TIA-568-C.1: Commercial Building Communications Cabling Standards, Part 1: General Requirements.
4. TIA-568-C.2: Balanced Twisted-Pair Communications Cabling and Components Standard.
5. TIA-568-C.3: Optical Fiber Cabling Components Standard.
6. TIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces.
7. TIA-606-A: Administrative Standard for Commercial Telecommunications.
8. ANSI/J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Communications.
9. TIA-758-A: Customer-Owned Outside Plant Communications Cabling Standard.
10. TIA-942: Telecommunications Infrastructure Standard for Data Centers.
11. ASTM: American Society for Testing and Materials
12. BICSI CO-OSP Design Manual (current edition): Customer-Owned Outside-Plant Design Manual.
13. BICSI Electronic Safety and Security (ESS) Design Reference Manual (current edition).
14. BICSI TDM Telecommunications Distribution Methods Manual (current edition).
15. TIA TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling.
16. ICEA: Insulated Cable Engineers Association
17. IEEE-802.3: 10Mb/s, 100Mb/s, 1Gb/s, and 10Gb/s Ethernet Standards as applicable based on media types (twisted pair copper, fiber optics, etc.)
18. IEEE-802.3ak: 10Gb/s Ethernet (evolving copper standard).
19. IEEE-802.3af: Power-over-Ethernet (PoE).
20. IEEE-1100-1999: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
21. IEEE-241: Recommended Practice for Electric Power Systems in Commercial Buildings.
22. ISO/IEC 11801: International Standard on Information Technology – Generic Cabling of Customer Premises.
23. NESC: National Electrical Safety Code
24. NEMA Std 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
25. NFPA-70/NEC: National Electrical Code.
26. NFPA-72: National Fire Alarm and Signaling Code
27. UL Compliance: Provide products which are UL-listed and labeled.
28. USDA Bulletin 1751F-643: Underground Plant Design.

B. Manufacturer and Product Qualifications

1. Provide products from manufacturers regularly engaged in the production of communications infrastructure components, including but not limited to, raceway, horizontal copper cabling, copper and fiber optic backbone cabling, and connecting hardware.
2. Provide products from manufacturers whose products of similar types, capacities, and characteristics have been in satisfactory use in similar type projects for not less than five years.

C. Contractor Qualifications:

1. Firms with at least seven (7) years of successful installation experience with projects utilizing communications structured cabling, media systems, infrastructure, raceway and equipment similar to that required for this project.
2. The company shall have a fully staffed office with technical installations support personnel within 30 miles of the project. (Exceptions to this shall be confirmed through approval by the Owner, Architect, Contractor, and Engineer.)
3. The Low Voltage Raceway Contractor shall be a certified installer (current and in good standing with proven history) of the selected manufacturer's raceway systems and shall provide a 25-year warranty on installation and applications.
4. The Low Voltage Cabling Contractor shall be a certified installer (current and in good standing with proven history) of the selected manufacturer's structured cabling systems, and shall provide a 25-year warranty on structured cabling installation and applications.
5. The company shall have a BICSI RCDD on staff.

D. All materials shall be Underwriters Laboratories (UL) or Intertek Testing Services (ETL) Listed unless otherwise indicated.

E. Coordinate with local communications service provider(s) for primary and diverse service to Telecommunications Demarcation location(s) within the facility.

F. Coordinate with electrical work and other trades to properly interface installation of telephone system with other work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment and components in factory-fabricated containers or wrappings, which properly protect equipment from damage.

B. Store equipment and components in original packaging. Store inside in a well-ventilated space protected from weather, moisture, soiling, humidity, and extreme temperatures.

C. Handle equipment and components carefully to prevent damage. Do not install damaged units or components; replace with new.

1.6 SEQUENCING AND SCHEDULING

A. All work shall be reviewed and coordinated with the Construction Manager and/or General Contractor prior to commencing.

B. Communication systems, infrastructure, raceway and equipment are sensitive to environmental conditions including but not limited to temperature, dirt, dust, and water. The contractor shall ensure the storage and installation of all communication components are sequenced and scheduled accordingly to prevent any damage, loss of performance, and warranty void of such systems. All mis-installed components shall be replaced with new parts and re-installed at the Contractor's expense.

C. Coordinate installation with Structural, Electrical, HVAC, Plumbing, Fire Protection, and other trades to eliminate disruption and/or conflict with other systems.

D. Coordinate underground installation with Civil, Structural, Electrical, and other trades to eliminate disruption and/or conflict with other systems (paving, curb and gutter, etc.).

E. Sequence installation of communications systems and infrastructure with other work to minimize possibility of damage and soiling during remainder of construction.

1.7 PROJECT SITE CONDITIONS

A. Prior to submitting a proposal, the Contractor shall inspect the Contract Documents, and shall become fully informed as to laws, ordinances, and regulations affecting the project. The Contractor shall immediately bring to the Owner, Architect, and Engineer's attention, in writing, any existing condition or statute that contradicts, is in conflict with, or negates the Contract Documents. Failure of the Contractor to become fully informed as to all above mentioned items shall in no way relieve the Contractor from any obligations with respect to their proposal.

B. The Technology Drawings depict equipment locations, backboxes, conduit runs, cabling, etc. in a schematic manner. Field conditions and coordination with related trades may warrant relocations of field devices. No additional compensation will be allowed due to these revisions.

1.8 WARRANTY

A. The manufacturer shall provide a warranty with a minimum term of 25-years for structured cabling and all communications cable infrastructure components. This warranty shall cover all components including cables, jacks, patch panels, and wiring panels, etc. to maintain the specified performance, physical criteria, and applications assurance. Any such components, link, or channel shall be replaced by the Manufacturer at no cost to Owner during this period. The Contractor and Manufacturer shall submit all information and documentation on Warranty.

B. A one (1) year warranty on the Work shall be provided by the Contractor. If, within one (1) year after the date of final acceptance of the installation or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents or provided by a manufacturer, any of the work or equipment is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly including all parts and labor after receipt of notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive termination of the contract. The Owner shall give such notice promptly after discovery of the condition. Such notice shall be provided by Owner representatives, to be identified, either verbally or in writing.

C. Nothing contained in the Contract Documents shall be construed to establish a shorter period of limitation with respect to any other obligation which the Contractor might have under the Contract Documents or any manufacturer's warranty. The establishment of the time period noted above, after the date of final acceptance or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents, relates only to the specific obligation of the Contractor to correct the work or equipment, and has no relationship to the time within which his obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to his obligations other than specifically to correct the work or equipment.

D. If system operation is not fully restored during the warranty period within two (2) business days, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.

E. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Contractor for such expansion without affecting the Contractor's responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment of system being expanded.

1.9 SPECIFICATION RESPONSE

A. Compliance

1. Provide a specification COMPLIANCE MATRIX indicating compliance or deviation for each item in the specification. The matrix shall be comprised of a list of all numbered paragraphs that appear in this Specification. This matrix is critical for proposal evaluation. Failure to submit may result in the disqualification of the bid. See example Compliance Matrix template in Appendix 2.
2. Additionally, as described in this Specification, bidders shall submit the following information with their submittal:

    a. Manufacturer's literature sheets for all standard manufactured items included in the equipment list and as proposed in the Voluntary Alternate Bid form, if applicable.

b. Workload and capability statements. The statements shall detail projects that will be active during the completion of this project, and the manpower that would be available for this project.
c. Confidentiality and return statements. The statements shall guarantee that the Contract Documents shall not be copied or distributed physically or verbally. The Contractor shall also assure the Owner that the Contract Documents shall be returned in their entirety upon request. The successful Contractor will be provided with as many copies as requested.
d. Copy of manufacturer's certification certificate.

1.10 DEFINITIONS

A. Acronyms and Definitions

1. Refer to Technology Symbol Legend and Abbreviations shown on drawings.

PART 2 - SPECIFICATIONS

2.1 GENERAL REQUIREMENTS

A. Refer to each of the specification sections listed below for requirements:

1. 27 05 26: Telecommunications Grounding and Bonding
2. 27 05 33: Telecommunications Raceway and Boxes
3. 27 05 36: Cable Trays
4. 27 05 43: Underground Ducts, Raceways and Manholes
5. 27 11 00: Communications Equipment Room Fit-out
6. 27 13 13: Communications Copper Backbone Cabling
7. 27 13 23: Communications Fiber Optic Backbone Cabling
8. 27 15 00: Communications Horizontal Cabling
9. 27 33 53: Technology Uninterruptable Power Supply (UPS)

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General:

1. The Contractor shall comply with all project expectations and submittal requirements as indicated in Part 1 of this specification. This includes initiating a "CA kickoff" meeting to discuss general project expectations with the project team.
2. Examine areas and conditions under which communications systems and infrastructure are to be installed. Notify Owner, Architect, and Engineer in writing of conditions

detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

3. The Contractor shall be knowledgeable of work to be performed by other trades and take necessary steps to integrate and coordinate their work with other trades.
4. The Contractor is required to coordinate their efforts with the other trades and sub-contractor who may be working within the same vicinity to avoid conflict and lost time.
5. The Contractor shall be responsible for furnishing all materials indicated on the drawings or as specified herein for a complete communications system.
6. The Contractor shall supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.
7. All communications infrastructure shall be installed in an aesthetically pleasing fashion. All surface raceway in new buildings must be approved by the Owner, Architect, and/or Engineer.
8. All communications infrastructure shall be installed for optimal performance.
9. All communications infrastructure shall be installed to allow for convenient operation, testing, and easy adds, moves, and other changes in the future.
10. All components noted in Technology drawings and specifications shall be provided and completely setup and installed.
11. The Contractor shall verify space requirements and locations before starting cable installations and terminations. Inappropriate conditions shall be immediately reported to Construction Manager or General Contractor, Owner, Architect, and Engineer prior to initiating installation.
12. The contractor shall not install any component in a manner or condition that will void manufacturer and/or contractor warranty. Any such conditions that prevent an acceptable install shall be immediately reported to Construction Manager or General Contractor, Owner, Architect, and Engineer prior to initiating installation. All mis-installed components will be removed and replaced with new at the Contractors expense. No additional cost will be submitted to Owner.

B. Communications Room Fit-out:

1. Construction within communication rooms must be substantially complete before the installation of telecommunications cabling. This includes, but is not limited to, the installation of plywood backboard, cable tray or ladder rack, electrical outlets, light fixtures, sprinklers and ductwork. All walls shall also be painted before the installation of telecommunications cabling.
2. Communications rooms must be free from dust, dirt, and other foreign materials before the installation of any termination hardware or the termination of copper or fiber optic cables. The door to the telecommunication rooms must be installed and closed during termination.
3. Floor to floor distribution shall be provided with concrete floor sleeves or conduits as noted on the drawings, and as required by the architectural design.

C. Communications Raceway Infrastructure:

1. Contractor shall provide conduits through walls and across inaccessible ceiling spaces to ensure unobstructed pathway back to the nearest communications room or cable tray.
2. Provide protective cable bushings on all conduits immediately after installation.
3. Use only electrical 45º or 90º conduit elbows with long bend radii as follows:

    a. 6:1 bend radius of the inside conduit diameter for sizes less than 2-inches.
    b. 10:1 bend radius of the inside conduit diameter for sizes 2-inches and greater.

4. Do not place more than two 90º sweeps or exceed 100 ft. between pull boxes without providing a pull box.
5. Fire-seal all raceway penetrations and openings to maintain fire rating after communications cables are installed.
6. Cable fill in riser conduits shall not exceed 40% cable fill.
7. Where applicable, the Contractor shall verify existing cable fill in riser conduit before installation of additional cables so as not to exceed 40% cable fill. Contractor will be responsible for installation of additional riser conduit, where additional cables to be added will exceed the 40% cable fill.

D. Communications Cabling Infrastructure:

1. Contractor shall not paint cables and/or spray cables with fire proofing material as it can affect cable performance and will void the cable warranty.
2. All communications cable routed within communications rooms shall be bundled and combed to provide a neat and organized appearance. Cables shall be bundled using only manufacturer and industry approved Velcro wire ties (zip ties shall not be used) with tensions that do not deform and damage cable resulting in loss of transmission or performance. Any bundles and combing methods used shall not exceed manufacturer or industry standards recommendations for that cable type.
3. Contractor shall provide dedicated J-hooks at 48-inches on-center for all communications cabling not run in conduit or cable tray.
4. The contractor shall not install any cable in conduits that do not have the appropriate protect bushings on conduit ends. All mis-installed cable will be removed, bushings installed, and new cable re-installed at the Contractors expense. No additional cost will be submitted to Owner.
5. Cable bends shall not be greater than that recommended by the manufacturer of the cable.
6. Care shall be taken so as not to damage cable during the installation process and that manufacturer’s pull tension specification is not exceeded.
7. Provide a minimum 8’-0” and maximum 10’-0” of slack. Loop at the IC-rooms to be contained on the horizontal cable tray or ladder rack.
8. Provide a minimum of 3’-0” of slack for all device cable termination points. Slack shall be contained in accessible ceiling near the final termination point or in the cable tray nearby when continuous conduit is routed back to cable tray.
9. Communications cabling that is bundled within cable trays and supported from j-hooks shall be snugly wrapped using Velcro reusable cable ties as minimum of every 3’-0” for cable organization. Velcro ties shall be tightened so as not to deform cable jackets and

thus affect cable performance. Plastic cable tie wraps shall not be used anywhere on the project.

10. Any other Low Voltage scopes including but not limited to BMS, Fire Alarm, AV and Broadcast cabling that are run in common communications infrastructure shall comply with the installation requirements in the division 27 specifications. The Contractor shall ensure that all scopes that use the installed infrastructure comply with these guidelines or provide dedicated pathways for those systems.

3.2 LABELING

A. All communications components shall be clearly labeled using labeling devices (i.e. handwritten labels are not acceptable) with white label and black text. All labels shall be consistent font type and size (for respective components).

B. The following indicates the recommended labeling scheme for various components. The final labeling scheme shall be coordinated with the Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.

1. Backbone Cables (to TRs):

    a. Label provided at both ends shall indicate origin room such as MTR (Main Telecom Room), the TR room designator (where cable is routed to) and a cable number if multiple cables are provided to a single TR location.

        1) Example: “MTR-3A” = single cable from MTR to TR on level 3, riser A.
        2) Example: “MTR-3A-2” = cable 2 of multiple cables from MTR to TR on level 3, riser A.

2. Backbone Cables (to Remote Hubs):

    a. Label provided at both ends shall indicate point of origin (i.e. MTR or TR designator), enclosure designator (where cable is routed to) and a cable number if multiple cables are provided to a single TR location.
    b. Enclosure boxes shall be indicated by an “E” followed by a number for the enclosure.

        1) Example: “MTR-E1” = single cable from TR to enclosure box “1”.
        2) Example: “3A-E4” = single cable from TR-3A to enclosure box “4”.

3. Horizontal Cables:

    a. Label provided at both ends shall indicate point of origin (i.e. MTR or TR designator), patch panel designator (A, B, C, etc.), and port number (01, 02, 03, etc.).

        1) Example: “MTR-A.23” = horizontal cable originating from port “23” on patch panel “A” at the MTR.
        2) Example: “3A-C.23” = horizontal cable originating from port “23” on patch panel “C” at TR-3A.

4. Device Faceplates:

    a. Label provided at each faceplate shall indicate point of origin (i.e. MTR or TR designator) for cables terminated at that device.

        1) Example: “MTR” = Device faceplate for cables originating from the MTR.
        2) Example: “3A” = Device faceplate for cables originating from TR-3A.

5. Device Outlets:

    a. Label provided at each device jack/outlet shall indicate patch panel designator (A, B, C, etc.) and port number (01, 02, 03, etc.) for cable point of origin.

        1) Example: “A.23” = horizontal cable originating from port “23” on patch panel “A” at the room indicated on the faceplate label.

6. Patch Panels (Horizontal and Backbone Cable Terminations):

    a. Labels provided at patch panels for HORIZONTAL cable terminations shall start with “A” for the first patch panel (in each room) and letter sequentially (B, C, etc.) thereafter.
    b. Labels provided at patch panels for BACKBONE cable terminations shall start with “AA” for the first patch panel (in each room) and letter sequentially (BB, CC, etc.) thereafter.
    c. Patch panel ports shall be labeled for each panel starting with “1” or “01” and numbering each port sequentially.

7. Fiber Termination Panels

    a. Label provided at termination panels for backbone or horizontal fiber optic cabling shall start with “1” for the first panel (in each room) and number sequentially (2, 3, etc.) thereafter.
    b. Fiber termination panel ports shall be labeled for each panel starting with “1” or “01” and numbering each port sequentially.

8. Wiring Blocks (Copper Backbone Terminations, if applicable)

    a. Label provided at termination panels for copper backbone cabling shall start with "1" for the first block (in each room) and number sequentially (2, 3, etc.) thereafter.

9. Cabinets / Racks

    a. Label provided at cabinets shall start with "CABINET-1" for the first cabinet (in each room) and number sequentially (CABINET-2, etc.) thereafter.
    b. Label provided at racks shall start with "RACK-1" for the first rack (in each room) and number sequentially (RACK-2, etc.) thereafter.

10. Grounding Busbars

    a. Labels are not required for the grounding busbars.

11. Grounding Conductors

    a. Label provided at the TMGB end of the Telecommunications Bonding Backbone (TBB) shall indicate the Communications Room where the cable originates from.

        1) Example: "5A" = TBB originating from TR-5A, routed down through Riser-A Communications Rooms and terminated on the TMGB.

    b. Label provided at each end of a Grounding Equalizer (GE) cable interconnecting two I-TGBs shall indicate both Communications room designators.

        1) Example: "3A-3D" = GE routed between I-TGBs in TR-3A and TR-3D.

    c. Label provided at each end of grounding cable routed from a ground busbar to the nearest Electrical Ground Busbar shall indicate the Communications room designator and "EGB" for nearest "Electrical Grounding Busbar."

        1) Example: "3A-EGB" = Grounding conductor routed between TGB in TR-3A and the EGB in the nearest Electrical Room.

    d. Label provided at each end of the Equipment Bonding Conductors (EBC) interconnecting each rack, cabinet, ladder rack, etc. within a Communications Room back to the TGB or TMGB shall start with "1" for the first cable (in each room) and number sequentially (2, 3, etc.) thereafter.

12. Conduits

    a. Label provided each end of Low Voltage conduits shall indicate the point of origin for the opposite end, such as the Communications Room designator or device location Room Number.
    b. Final room number labeling shall be coordinated with the Owner, Architect, and Engineer prior to initiating work.

c. Horizontal device conduit originating from a nearby cable tray (if applicable) shall indicate “TRAY” at the device end and the device location (i.e. room number) at the cable tray end.
d. Horizontal device conduit originating from accessible ceiling directly above a device does not require labels at either end.
e. Conduit sleeves (10-ft or shorter) do not require labels at either end.

13. Pull-boxes

a. Label provided pull-boxes or conduit ends terminating into a pull-box shall clearly indicate where each conduit originates from, based on “conduit” section above.

END OF SECTION 27 05 00

APPENDIX 1 - EQUIPMENT SCHEDULE

NOTE: There is no product number appendix for this section. Refer to other Division 27 specification sections for specific product information.

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

APPENDIX 3 - PRODUCT DATA & SHOP DRAWING SUBMISSION CHECKLIST

NOTE: Contractor shall utilize checklist below to ensure comprehensive product data and shop drawings are submitted for review, including submittals compiled between multiple sub-contractors (as applicable). This checklist is intended help establish submittal expectations specific to each specification section and to serve as a pre-check document for each contractor. Refer to submittal section of these specifications for additional requirements.

	GENERAL ITEMS
	Compliance matrix
	Proposed project schedule (procurement, installation, final testing/punch, etc.)
	PRODUCT DATA
	Manufacturer warranty information
	Equipment component list
	Equipment specification sheets
	Refer to 27 05 00 section 1.3-C for additional requirements.

	SHOP DRAWINGS
	27 05 00 (General requirements, applicable to all specification sections)
	All shop drawings, product data and compliance matrix to be submitted together
	Combined legends, plans, details, etc. may be provided to encompass multiple specification sections
	Refer to 27 05 00 section 1.3-D for additional requirements.

	27 05 26
	27 05 26 and 27 11 00 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate all cable types/rating, routing, connection points, labeling, etc.
	Details: indicate busbar components, connection types/points, etc.

	27 05 33
	27 05 33, 27 05 36, and 27 05 43 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate riser conduits / tray, conduit allocation per system (including spares), etc.
	Site plan: indicate other utilities, manholes, conduit types, entry points, light pole tie-ins, etc.
	Floor plans: indicate rated walls/floors, tray/conduit routes, floor boxes, pull-boxes, plenum boxes, etc.
	Details: indicate conduit support systems, grounding, fire-proofing methods, etc.

	27 05 36 (submit cable tray specific shop drawings with RCPs shown)
	27 05 33, 27 05 36, and 27 05 43 to be submitted together
	Legend: indicate symbol key (including mounting height tags), scope clarification notes, etc.
	RCPs: indicate ceiling types, rated walls/floors, tray/conduit routes, access/clearances, etc.
	Details: indicate tray support systems, grounding, fire-proofing methods, etc.

	27 05 43
	27 05 33, 27 05 36, and 27 05 43 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	Site plan: indicate other utilities, manholes, conduit types, entry points, light pole tie-ins, etc.
	Floor plans: indicate conduit stub-up locations within building, conduit type transition points, etc.
	Details: indicate conduit trench, spacers, grounding, etc.

	27 11 00
	27 05 26 and 27 11 00 to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	Floor plans: indicate rack positions, ladder rack, conduit allocation and stub-up locations, etc.
	Wall elevations: indicate wall mounted cable tray, conduit stub-ups, wall mounted SCPs, CATV, DAS, etc.
	Rack elevations: indicate patch panels, cable managers, PDUs, UPS, network equipment, etc.
	Details: indicate cable tray mounting details, conduit supports, rack-to-floor attachments, etc.

	27 13 13
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate all cable types/rating, routing, termination types, labeling, etc.
	Rack elevations: submit with 27 11 00
	Details: indicate termination plate details and placement in remote enclosures, AV racks, etc.

	27 13 23
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate all cable types/rating, routing, termination types, labeling, etc.
	Rack elevations: submit with 27 11 00
	Details: indicate termination plate details and placement in remote enclosures, AV racks, etc.

	27 15 00
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	Site plan: indicate OSP cable routes, encoder locations, light poles, pedestals, etc.
	Floor plans: indicate updated comm room divider lines, device labels, typical conduit paths, etc.
	Rack elevations: submit with 27 11 00
	Details: indicate termination plate details and placement in remote enclosures, AV racks, etc.

	27 41 00
	All Div.27 AV submittal sections to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate detailed connectivity one-lines depicting all components, wiring, connections, etc.
	Site plan: indicate OSP cable routes, device locations, light and/or speaker poles, etc.
	Floor plans: indicate component locations and sizes (racks, raceway, active components, etc.),
	device labels, typical conduit / cable paths, etc.

	27 41 00 (Continued)
	RCPs: indicate current ceiling layer, ceiling device placement, lifts, access hatches, etc.
	Elevations: indicate AV rack elevations with detailed equipment layouts
	Details: indicate final connection plate details, equipment mounting details, etc.

	27 41 40
	All Div.27 AV submittal sections to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate detailed connectivity one-lines depicting all components, wiring, connections, etc.
	Floor plans: indicate device locations, device labels, cable types and distances, back-box sizes, etc.
	Elevations: indicate wall elevations with detailed equipment layouts (amps, splitters, taps, etc.)
	Details: indicate final connection plate details, equipment mounting details, etc.

	27 51 16
	All Div.27 AV submittal sections to be submitted together
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate detailed connectivity one-lines depicting all components, wiring, connections, etc.
	Floor plans: indicate device locations, device labels, cable types and distances, back-box sizes, etc.
	Elevations: indicate wall elevations with detailed equipment layouts (amps, splitters, taps, etc.)
	Details: indicate final connection plate details, equipment mounting details, etc.

	27 51 23
	27 51 23 to be submitted with Div.28 security submittals
	Legend: indicate symbol key, labeling scheme, scope clarification notes, etc.
	One-lines: indicate schematic one-lines depicting all components, wiring, connection points, etc.
	Floor plans: indicate device locations, device labels, typical conduit paths, associated cameras, etc.
	Details: indicate selected intercom stations and associated back-boxes, mounting details, etc.

SECTION 27 05 26 - TELECOMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

F. Rough carpentry is specified in a Division 6 section.

1.2 SUMMARY

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Extent of telecommunications grounding and bonding work is indicated by Technology Drawings (one-line, enlarged plans, and details) and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

C. A dedicated telecommunications ground system shall be provided with insulated bonding backbones (TBB) as applicable, equalizing conductors (TEC) as applicable, and pre-drilled tinned copper busses (TMGB and TGB) shall be provided at each communications room to bond metallic equipment and hardware components.

D. Applications of telecommunications grounding and bonding work in this section includes, but may not be limited to: raceways such as conduits and cable trays, metallic cable sheaths, equipment enclosures, cabinets and racks, building structure, electrical power and/or grounding systems components, service equipment, etc.

E. Refer to other Division 26 and Division 27 sections for wires/cables, telecommunications raceways, boxes and fittings, and wiring devices which are required in conjunction with telecommunications grounding and bonding work; not work of this section.

1.3 SUBMITTALS

A. General Description and Requirements

1. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Product Data:

1. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

C. Prefabrication Shop Drawings:

1. One-Line Wiring Diagrams: Include one-line wiring diagrams for telecommunications grounding and bonding work which indicate layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, equipment grounding connections and busbars.
2. Details: Indicating grounding method for cable tray and cabinets and/or racks.
3. Labeling: Provide documentation of all labeling schemes for grounding busbars and grounding conductors.
4. Documentation: Provide an electronic copy for review or as indicated in Division 1 general conditions.

1.4 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.

C. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with telecommunications grounding work similar to that required for project.

D. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and the current edition of the NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
2. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition,

comply with UL Std 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

3. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
4. TIA Compliance: Comply with applicable requirements and recommended installation practices of the current editions of TIA Standards 568, 569, and 607.
5. BICSI Compliance: Comply with applicable requirements and recommended installation practices of the current editions of BICSI Standards TDM, CO-OSP, Data Network Design Reference Manual, and Wireless.

PART 2 - SYSTEM REQUIREMENTS

2.1 GENERAL

A. Materials and Components:

1. Provide telecommunications grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, IEEE, NEMA, ANSI, TIA, and BICSI requirements and with established industry standards for those applications indicated.

2.2 BUS BARS

A. Materials and Components:

1. Provide telecommunications grounding bus bars with a TIA J-STD-607-A style and **BICSI recommended bolt pattern**.

B. Telecommunications Grounding Busbar (TMGB):

1. Refer to Technology Drawings (grounding details) for additional requirements such as bonding conductor connections and dual busbar locations (such as TMGB) as applicable. Contractor shall provide multiple busbars if necessary, to accommodate the quantity of grounding cables that shall tie into the busbar, in particular the TMGB on larger projects.
2. Provide tinned copper UL listed bus with pre-drilled two-hole bonding lugs.
3. Pre-drilled holes shall be primarily for 4 AWG two-hole bonding lugs. Holes shall be a nominal diameter of 5/16-inch (8mm) with 5/8-inch (16mm) between the holes centerline.

4. Grounding busbar shall also have a minimum of (6) pre-drilled two-hole lug points for #3/0 AWG bonding lugs. Holes shall be a nominal diameter of 7/16-inch (11mm) with 1-inch (25mm) between the holes centerline.
5. Grounding busbar shall have isolated stand-offs to provide a minimum 1-inch clearance off of wall.
6. Physical Size: 20-inch x 4-inch x 1/4-inch (600mm x 100mm x 6mm).

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.

1. Telecommunications Bonding Backbone (TBB): Provide #3/0 AWG, unless noted otherwise.
2. Telecommunications Grounding Equalizers (GE): Provide #3/0 AWG, unless noted otherwise.
3. Tap Conductors: Provide #3/0 AWG unless noted otherwise.
4. Equipment and Component Bonding Conductors (EBC): Provide No. 4 or No. 6 AWG, insulated stranded conductors based on conductor distances.
5. ESD Floor Bonding Strap: Provide/install bonding strap in accordance with the flooring manufacturers requirements.

2.4 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Compression Fittings: All cable splices from bonding backbone to tap conductors shall use irreversible compression fittings to join cable ends.

C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits of types recommended by Cadweld (or approved equal) manufacturer for materials being joined and installation conditions.

E. Compression Fittings: All cable splices from bonding backbone to tie cables shall use irreversible compression fittings to join cable ends.

2.5 GROUNDING ELECTRODES

A. Ground Rods and Electrodes for use in telecommunications manholes:

1. Ground Rods: Copper clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
2. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

    a. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
    b. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Stranded conductors shall be used for all telecommunication ground cables, unless otherwise indicated.

B. Underground Grounding Conductors: Install, #3/0 AWG insulated copper conductors in conduits.

1. Bury at least 24 inches (600 mm) below grade or below frost line (whichever is deeper).
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Telecommunications Main Grounding Bus (TMGB):

1. Refer to Technology drawings for exact location.
2. Install bus on insulated spacers 1-inch (25 mm) minimum, from wall and 12-inches (300 mm) above finished floor, unless otherwise indicated.
3. The TMGB shall be connected to the main electrical service ground bus with an insulated #3/0 ($120mm^2$) stranded grounding conductor installed in continuous conduits.
4. The TMGB shall be connected to building steel if existing within room with an insulated #3/0 AWG ($120mm^2$) stranded grounding conductor.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2, TIA and BICSI grounding requirements

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 EQUIPMENT AND COMPONENT GROUNDING

A. Install insulated equipment grounding conductors to all telecommunications equipment and components.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70, NEMA, ANSI, TIA and BICSI:

1. Armored and metal-clad cable sheaths.
2. Equipment Cabinets and Racks.
3. Cable trays and ladder racks.
4. Conduits sections and conduit sleeves.
5. Equipment and Power Supply Enclosures.
6. Wall mounted cable terminals.
7. Other metallic components as necessary.
8. ESD Flooring

3.4 EXAMINATION

A. Examine areas and conditions under which telecommunications grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.5 INSTALLATION OF TELECOMMUNICATIONS GROUNDING AND BONDING SYSTEMS

A. General: Install telecommunications grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Labeling:

1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

C. Coordinate with other electrical and telecommunications work as necessary to interface installation of telecommunications grounding and bonding system work with other work.

D. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

E. Ground Rods: Drive rods until tops are 2-inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

F. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
3. **Coordinate with flooring contractor prior to installation for proper installation of bonding straps installed during the flooring installation.**

G. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

H. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts.

Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

I. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

J. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.6 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

END OF SECTION 27 05 26

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
   a. Chatsworth-CPI
   b. General Cable
   c. Panduit
   d. Southwire

Table 1 - Telecom Grounding Components

Item	Part Name/Description	Manufacturer	Part Number
1	Telecom Main Grounding Busbar - 4"W x 20"L	Chatsworth-CPI	40153-020
		Legrand / Ortronics	GB4X20TMGB
		Panduit	GB4B0624TPI-1
2	Compression Lugs - #6AWG	Chatsworth-CPI	40162-951
		Legrand / Ortronics	CL2LB6A
		Panduit	LCC6-14JAW-L
3	C-Type Compression Taps	Chatsworth-CPI	40163-059
		Legrand / Ortronics	CTHD4666
		Panduit	CTAP4/0-4/0-X
4	3/0 Grounding Conductor (Green)	Southwire	GN:556123
		*Other	Submit for approval
5	#6 AWG Bonding Conductor (Green)	Southwire	GN:204974
		*Other	Submit for approval

Table 1 - Telecom Grounding Components			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
6	Ground Strap	Chatsworth-CPI	40159-009
		Legrand / Ortronics	GS-8
		Panduit	GACBJ

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 05 33 - TELECOMMUNICATIONS RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: There is no product number appendix for this section. Submit proposed raceway products as described within this specification and on the Technology Drawings.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods section.

F. Division 26 Raceway and Boxes section for conduit connectors, fittings, and couplings.

G. Division 7 Section “Firestopping” for conduit penetrations through rated walls and slabs.

1.2 SUMMARY

A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.

B. This Section includes raceways for Communications and Security cabling. Types of raceways, boxes and fittings in this section include the following:

1. Electrical metallic tubing (EMT).
2. Intermediate metal conduit (IMC).
3. Rigid non-metallic conduit (RNC)
4. High-density Polyethylene conduit (HDPE)
5. Outlet boxes.
6. Junction boxes.
7. Pull boxes.
8. Bushings.
9. Locknuts.
10. Knockout closures.

1.3 SUBMITTALS

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Product Data: This section does not have a "benchmark" product Appendix; thus, Contractor shall submit product data for all applicable products as required per Technology Drawings including, but not limited to:

1. Raceways and fittings.
2. Wireways and fittings.
3. Boxes and fittings.

C. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

A. In addition to Section 27 05 00 requirements, the following shall apply to this specification section.

1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
2. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.
3. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

PART 2 - SYSTEM REQUIREMENTS

2.1 METAL CONDUIT AND TUBING

A. Electrical Metallic Tubing (EMT) and Fittings: ANSI C80.3.

1. EMT shall be used for standard device outlet raceway, unless otherwise noted.
2. EMT shall be used for backbone conduit sleeves stubbed through floors.

B. Intermediate Metallic Conduit (IMC) and Fittings:

1. IMC shall be used for device outlets mounted below 10-ft in high traffic areas such as garages, loading docks, service tunnels, etc.
2. IMC shall be used for extending service entrance cable from building point of entrance to termination or transition point when the distance exceeds 50 feet.

2.2 NONMETALLIC CONDUIT AND DUCTS

A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.

1. RNC shall be used for all permanent underground incoming service and/or “campus” backbone conduits to additional buildings.

B. High-Density Polyethylene (HDPE) Conduit and Tubing Fittings: Schedule 40 or 80, NEMA TC 7; match to conduit or conduit/tubing type and material.

1. HDPE shall be used for all temporary underground incoming service and/or “campus” backbone conduits to additional buildings.
2. Conduit shall be smooth outer wall and ribbed inner wall design.

C. Conduit, Tubing and Duct Accessories: Types, sizes and materials complying with manufacturer’s published product information. Mate and match accessories with raceway.

D. Electrical non-metallic tubing (ENT): NEMA TC13 and UL1653.

2.3 CONDUIT BODIES AND FITTINGS

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching covers with gaskets secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways. Use conduit bodies conforming to UL514B.

C. EMT Conduit Bodies: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.

D. HDPE: Use nonmetallic conduit bodies conforming to UL651A.

E. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit, IMC and EMT, larger than 3/4-inch size.

F. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25-feet (7.6m) or less, and the long type in runs 26 to 80-feet (7.9 to 24.3m). The long type shall be a two piece barrel and piston joint, providing 6-inch (150mm) of the total movement range in 3/4-inch (19-mm)through 6-inch (150mm)” conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2-inch (50mm) of total movement range in 3/4 to 2-inch (19 to 50mm) conduit sizes.

G. Seal Off Fittings: Threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

2.4 FABRICATED MATERIALS - BOXES

A. Device Outlet Back-Boxes: Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes (two-gang, 4 11/16-inch x 4 11/16-inch 2 1/8-inch deep (120mm x 120mm x 54mm)), including box depths as required, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

1. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
2. Outlet Box Device Covers: Provide box covers as an individual component. In no instance shall a pre-fabricated box with a fixed box cover be utilized. All device covers shall be inter-changeable in the field based on openings requirements at respective locations. Box covers shall not be used as the box mounting bracket or as the mounting mechanism.

B. Rain-tight and Weatherproof Outlet Boxes: Weatherproof devices shall be provided at all exterior locations and any location susceptible to water and other exterior conditions. Provide corrosion-resistant cast-metal rain-tight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening telecommunications conduit, cast-metal and plastic face plates with spring-hinged watertight covers (polycarbonate) suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners. Watertight cover shall allow for patch cords to be plugged in and sealed while in operation.

C. Junction and Pull Boxes: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match flush mounted panel board trim. Exact size

shall meet minimum industry standards based on conduit quantities and stacking arrangement, as indicated in the table below:

Conduit Trade Size mm (in)	Width mm (in)	Length mm (in)	Depth mm (in)	Width Increase for Additional Conduit mm (in)
27 (1)	101 (4)	406 (16)	76 (3)	51 (2)
35 (1-1/4)	152 (6)	508 (20)	76 (3)	76 (3)
41 (1-1/2)	203 (8)	686 (27)	101 (4)	101 (4)
50 (2)	203 (8)	914 (36)	101 (4)	127 (5)
63 (2-1/2)	254 (10)	1067 (42)	127 (5)	152 (6)
78 (3)	305 (12)	1220 (48)	127 (5)	152 (6)
91 (3-1/2)	305 (12	1370 (54)	152 (6)	152 (6)
100 (4)	381 (15)	1525 (60)	203 (8)	203 (8)

D. Exterior junction or pull boxes, flush with grade:

1. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Minimum box dimensions shall be 30-inch W x 60-inch L x 24-inch D (750mm x 1500mm x 600mm) or as indicated on the drawings. Exact size shall be provided to meet industry standards based on conduit quantities and stacking arrangement. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.

E. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

2.5 FIRESTOPPING - UL 1489

A. Provide firestopping pillows, bricks or puttys as required in all conduit openings to maintain rating of the wall. Fireproofing shall consist of ready to use, intumescent fibrous material enclosed in a strong polyethylene envelope. Contractor shall assume this is to be included in the raceway scope of work, unless directed otherwise by the Construction Manager and/or General Contractor.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Outdoors: Use the following installation methods:

1. Exposed: Intermediate metal conduit.
2. Concealed: Intermediate metal conduit.
3. Underground, Single Run: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
4. Underground, Grouped: Rigid non-metallic conduit. PVC coated GRC 90° elbows.
5. Temporary: HDPE PVC Sch40/80.

B. Indoors: Use the following installation methods:

1. Exposed (below 10 ft. to floor): Intermediate metal conduit
2. Exposed (above 10ft. or in electrical room): Electrical metallic tubing.
3. Concealed: Electrical metallic tubing.
4. Service entrance extension beyond 50-feet: Intermediate metal conduit.

3.2 INSTALLATION OF RACEWAYS

A. General: Install telecommunications raceways in accordance with manufacturers' written installation instructions, applicable requirements of NEC, NEMA, ANSI, TIA, BICSI, and as follows.

B. Labeling:

1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

C. Clearances: Telecommunications raceway shall be routed to maintain appropriate clearances from potential interfering electrical sources per NEC, NEMA, ANSI, TIA, and BICSI requirements. Provided below are minimum requirements of key components that shall be maintained. For any instances where field conditions do not allow for the minimum clearances, the Contractor shall notify the Architect and Engineer so that an acceptable solution can be coordinated.

1. 120V Power Conduits: 6-inches (150mm)
2. 208V and Higher Power: 24-inches (600mm)
3. Lighting System: 12-inches (300mm)
4. Transformers: 48-inches (1200mm)
5. Motors and Fans: 48-inches (1200mm)

6. Other Interfering Sources to be field verified and coordinated by Contractor with Architect and Engineer.

D. Unobstructed Cabling Pathways:

1. Raceway installer shall provide conduit sleeves through all walls and continuous segments above inaccessible ceiling spaces to ensure unobstructed cable pathways are provided from each device location back to the appropriate HC. (Refer to Technology Drawings for additional information.)

E. Horizontal Distance Limitations:

1. Communications horizontal cabling shall not exceed a total cable length of 295-feet (90m) for the permanent basic link. The channel length shall not exceed 325-feet (100m) when patch cords are installed.
2. Contractor(s) responsible for providing the communications horizontal raceway shall ensure that unobstructed pathway to each device location does not cause cable to exceed 295-feet (90m) length from to the nearest horizontal cross-connect (HC) location. This may require unobstructed pathway to be no more than 250-ft (76m) to accommodate necessary cable slack. Contractor shall bring any distance concerns to the attention of the Architect and Engineer during the bid process and/or at a minimum during the shop drawing process, prior to installation.

F. Telecommunications conduits shall maintain large bends and sweeps. Provided below are the ratios for minimum conduit bend radius to conduit size diameter.

1. Smaller than 2-inches (50mm) : 6:1
2. 2-Inches (50mm) and Larger: 10:1

G. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 6-inches (150mm) away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

H. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.

I. Complete installation of telecommunications raceways before starting installation of conductors within raceways.

J. Provide supports for raceways as specified elsewhere in Electrical and/or Communications specification sections and in accordance with NEC and local authorities' seismic requirements.

K. Prevent foreign matter from entering raceways by using temporary closure protection.

L. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells.

M. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

N. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.

O. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.

P. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.

Q. All exposed conduits in public areas shall be painted to match surrounding walls. Verify exact color with the Architect. Painting specified herein shall be provided by others.

R. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.

S. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.

T. Tighten set screws of threadless fittings with suitable tool.

U. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.

V. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

W. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.

X. Telecommunications raceways shall have a maximum pulling length of 100 feet and a maximum of two 90° bends or equivalent. A pull-box or junction-boxes shall be provided where necessary to comply with these requirements.

Y. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
2. Where required by the NEC.

Z. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.

AA. Flexible connection: Use flexible conduit with a maximum length of 6-feet (3m) for furniture feeds. Use liquid-tight flexible conduit in wet locations. Install separate equipment grounding conductor across flexible connections.

BB. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

CC. All underground conduits shall be installed a minimum of 24-inches (600mm) below finish grade or below frost line, whichever is deeper.

DD. Telecommunications service entrance cables that extend beyond 50-feet from the building point of entrance shall be in IMC from the point of entrance to the point of termination without breaks as require by the NEC.

EE. Daisy Chaining of pathways shall not be allowed unless specifically noted on the drawing or detailed on drawings. Each backbox shall be installed with a dedicated pathway. Any proposed or required daisy chaining will be detailed in contractor shop drawings and submittals and approved prior to installation. Any remediation to dedicated pathways as required will be the total responsibility of the Contractor at no additional cost to Owner.

FF. Provide pedestrian walk over guards for all temporary surface conduit routed in pedestrian zones.

3.3 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

C. Provide rain-tight or weatherproof covers for all communications device outlets at all interior and exterior locations exposed to weather or moisture.

D. Provide knockout closures to cap unused knockout holes where blanks have been removed.

E. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

F. Installing boxes back-to-back in walls shall not be permitted. Provide no less than 12-inches (150mm) of separation.

G. Position recessed outlet boxes accurately to allow for surface finish thickness.

H. Do not use round boxes where conduit must enter box through side of box, which would result in difficult and unsecure connections when fastened with locknut or bushing on rounded surfaces.

I. Fasten telecommunication and electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.

J. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.

K. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.

L. Subsequent to installation of boxes, protect boxes from construction debris and damage.

M. Outlet back-boxes shall be installed straight on walls to provide a neat appearance of faceplates on finished walls.

3.4 GROUNDING

A. Upon completion of installation work, properly ground telecommunications boxes and demonstrate compliance with requirements.

3.5 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

END OF SECTION 27 05 33

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an “end-to-end” solution is provided by one of the “pre-approved” manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish “benchmark” products from one or more of the “pre-approved manufacturers”. The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
   a. Abesco
   b. Hilti
   c. STI

Table 1 - Fire Stopping			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
1	EZ Path Smoke pathway *Sizes per drawings (4"x4")	STI	NEZ44 *Others as applicable
2	Flexible Firestop Block	Hilti	CFS-BL
3	Cable Transit Firestop Device - Round *Sizes per drawings (2" dia, 4" dia)	Abesco	31938, 31950 *Others as applicable
4	Cable Transit Firestop Device - Square *Sizes per drawings (2.5", 4")	Abesco	31940, 31942 *Others as applicable

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 05 43 - UNDERGROUND DUCTS, RACEWAYS AND MANHOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: There is no product number appendix for this section. Submit proposed raceway products as described within this specification and on the Technology Drawings.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 3 Concrete

F. Division 26 Basic Electrical Materials and Methods section

G. Division 27 Telecommunications Grounding and Bonding

H. Division 27 Telecommunications Raceways and Boxes

I. Division 31 Earthwork

1.2 SUMMARY

A. Provide all necessary components including, but not limited to, conduits, manholes and grounding for telecom service entrance from property line to each demarcation/main communications room.

B. Drawings are diagrammatic. All bends, fittings, and couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.

C. Furnish all labor, materials, tools, equipment, and services for all underground service and manholes as indicated, in accordance with provisions of Contract Documents.

D. Completely coordinate with work of all other trades.

1.3 SUBMITTALS

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Product Data: This section does not have a "benchmark" product Appendix, thus Contractor shall submit product data for all applicable products as required per Technology Drawings including, but not limited to:

1. Manholes, Pull Boxes, Handholes.
2. Duct bank materials, including spacers and miscellaneous components.
3. Warning tape and tracer wire.
4. Conduits.
5. Inner-Ducts

C. Shop drawings:

1. Site plan: Provide complete site plan showing all existing and proposed utilities. Manholes, handholes, and major raceway 2-inches and larger shall be indicated. Shop drawings shall represent final conduit routing and manhole/handhole placement as coordinated with Service Provider, Civil Engineer, and other applicable trades.
2. Details:

    a. Duct bank sections: Provide duct bank section drawing for each unique length of trench.
    b. Manholes, Pullboxes, Handholes: Provide details indicating:

        1) Conduit size and entry locations
        2) Cover design
        3) Racking type and locations
        4) Grounding details

3. One-Line Drawings: Provide one-line drawings indicating connection to existing site infrastructure.

D. Test reports as required for compaction and concrete work in Division 3 and 31.

1.4 QUALITY ASSURANCE

A. Manufacturer qualifications

1. Provide products from manufacturers regularly engaged in the production of communications infrastructure components, including but not limited to, manholes, hand holes, and hardware.

2. Provide products from manufacturers whose products of similar types, capacities, and characteristics have been in satisfactory use in similar type projects for not less than five years.

B. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

C. Compaction density test: ASTM D1557.

D. Contractor will hire an independent soils laboratory to conduct in place moisture-density tests to insure that all work complies with this specification.

1. Notify Construction Manager or Owner's representative at least 2 weeks prior to anticipated date of testing.
2. Contractor will pay additional cost if work is delayed due to his failure to notify Owner's agent as specified above.

E. Comply with all aspects of "Safety Rules & Regulations for Excavation: as promulgated by the state in which excavation will occur.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver equipment and components in factory-fabricated containers or wrappings, which properly protect equipment from damage.

B. Store conduit to avoid warping or deterioration with end caps.

C. Store plastic conduit on flat surface protected from direct rays of sun.

D. Handle equipment and components carefully to prevent damage. Do not install damaged units or components; replace with new.

1.6 SEQUENCING AND SCHEDULING

A. All work shall be reviewed and coordinated with the Construction Manager and/or General Contractor prior to commencing.

B. Coordinate installation with Civil, Structural, Electrical, and other trades to eliminate disruption and/or conflict with other systems (paving, curb and gutter, etc.).

1.7 PROJECT SITE CONDITIONS

A. Prior to submitting a proposal, the Contractor shall inspect the Contract Documents, and shall become fully informed as to laws, ordinances, and regulations affecting the project. The Contractor shall immediately bring to the Owner, Architect, and Engineer's attention, in

writing, any existing condition or statute that contradicts, is in conflict with, or negates the Contract Documents. Failure of the Contractor to become fully informed as to all above mentioned items shall in no way relieve the Contractor from any obligations with respect to their proposal.

B. The Technology Drawings depict equipment locations and conduit runs in a schematic manner. Field conditions and coordination with related trades may warrant relocations of field devices. No additional compensation will be allowed due to these revisions.

1.8 WARRANTY

A. The manufacturer shall provide a warranty with a minimum term of 25-years for all structures and components. This warranty shall cover all components including manholes, handholes, racking, etc. to maintain the specified performance, physical criteria, and applications assurance. Any such components shall be replaced by the Manufacturer at no cost to Owner during this period. The Contractor and Manufacturer shall submit all information and documentation on Warranty.

B. A one (1) year warranty on the Work and Compaction shall be provided by the Contractor. If, within one (1) year after the date of final acceptance of the installation or within such longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents or provided by a manufacturer, any of the work or equipment is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly including all parts and labor after receipt of notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. This obligation shall survive termination of the contract. The Owner shall give such notice promptly after discovery of the condition. Such notice shall be provided by Owner representatives, to be identified, either verbally or in writing.

C. Nothing contained in the Contract Documents shall be construed to establish a shorter period of limitation with respect to any other obligation which the Contractor might have under the Contract Documents or any manufacturer's warranty. The establishment of the time period noted above, after the date of final acceptance or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents, relates only to the specific obligation of the Contractor to correct the work or equipment, and has no relationship to the time within which his obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to his obligations other than specifically to correct the work or equipment.

D. If system operation is not fully restored during the warranty period within two (2) business days, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.

E. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Contractor for such expansion without affecting the Contractor's

responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment of system being expanded.

1.9 SPECIFICATION RESPONSE

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.10 DEFINITIONS

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

PART 2 - PRODUCTS

2.1 DUCT SYSTEM

A. Duct System: Multiple and single, conduits completely encased in concrete.

1. Separators: Plastic or other non-metallic, non-decaying material.
2. Inner-Ducts: Provide (3) inner-ducts in each conduit as indicated on Technology Drawings.

B. Pull Wire: No. 9 galvanized iron, or heavy nylon cord, free of kinks and splices.

1. Marked with length every 10’.

C. Detectable Warning Tape:

1. Polyethylene plastic warning tape

    a. Detectible warning tape can be used to provide tracer wire and warning tape only if conduits aren’t encased in a concrete duct way. Concrete ductway shall include tracer and non-detectible warning tape.
    b. 6” width and 10mm thick
    c. Integral wires, foil backing or other means of detection up to 3’ deep.
    d. Tape to be orange in color and read “CAUTION, BURIED COMMUNICATIONS LINE BELOW” or as required by local code.

D. Non-detectable Warning Tape:

1. Polyethylene plastic warning tape

   a. 6” width and 10mm thick
   b. Tape to be orange in color and read “CAUTION, BURIED COMMUNICATIONS LINE BELOW” or as required by local code.

E. Tracer Wire:

1. #6 AWG bare copper wire.

2.2 HANDHOLES

A. Telecommunications Handholes: Sizes as indicated on drawings:

1. Concrete: 4500 PSI. Conform to Division 3 requirements.
2. HS-20 rated for traffic rated conditions.
3. Cover and frame: 36” diameter, gray cast iron with machine finished seat for perfect joint between cover and frame. “COMMUNICATIONS” to be stamped on cover.
4. Provide floor drain with grate.
5. Provide accessories per Telecommunication drawings.

B. Cable Pulling Irons: Galvanized, mounted on wall.

1. 7/8-inch diameter installed 3” to 9” above the floor and embedded in wall during construction.

C. Cable Racks: Galvanized, mounted on wall.

1. Provide minimum (3) cable racks on each long wall with minimum of 8 adjustable hooks; minimum 2 spare hooks on each rack.
2. Insulators: Best quality, high glazed porcelain; provide for each hook.
3. Space racks so each end of splices is supported horizontally.

D. Ladder: Galvanized.

1. Each manhole and handhole to contain its own ladder.

E. Sump Pit:

1. Provide 12” diameter by 24” deep sump recess with removable perforated grate. Refer to Division 31 for base course material.

F. Grounding:

1. Refer to Section 27 05 26 for requirements that shall be fulfilled as part of this specification section.

PART 3 - EXECUTION

3.1 INSTALLATION OF HANDHOLES

A. Determine exact location of each manhole after careful consideration has been given to location of other utilities, grading, and paving.

1. Do not begin construction until location of each manhole has been reviewed by Architect/Engineer.

B. Construct manholes and/or handholes of type indicated in accord with applicable details.

1. Mix, place and cure concrete or set precast unit on non-expansive soil bed in accord with Division 3 and 31 requirements.

C. Set frames and cover:

1. Paint exterior with 2 coats asphaltic paint after inspection and before setting.
2. Set top of manhole and/or handhole minimum 12” below finished grade to allow for soil amendments and planting or roadway surface. Coordinate with Civil Engineer for roadway surface section depth.
3. In paved areas, set top of manhole covers flush with finished surface of paving.
4. In unpaved areas, set top of manhole covers approximately ½” above finished grade.
5. Where final grades are higher than top of manhole, install sufficient number of courses of grade rings between top of manhole and manhole frame to elevate manhole cover to final grade level.

D. Install cable racks, ladder and cable pulling irons.

E. Provide ground rods, bonding ribbon, and ground wires per Section 27 05 26.

3.2 DUCT BANK

A. Form all duct banks in square or rectangular fashion as shown. Install duct spacers per manufacturer’s requirements.

B. Pitch conduits a minimum 1:300 down towards manhole and/or handhole and away from building. Slope conduits from a highpoint midway between manholes.

C. Install tracer wire in top 2” of concrete encasement. Tracer wire shall be attached to the inside of the manhole near lid with sufficient slack to reach opening.

D. Install warning tape 12” above top of duct bank.

E. Adjust final slopes on-site to coordinate with utilities and structure.

F. Backfill and compaction requirements per Division 31 requirements.

G. After installation, clean and swab ducts.

H. Install galvanized steel pullwires in spare ducts. Cap empty ducts with screw covers.

I. Label conduit at stub-up and manhole penetrations in accordance with Section 27 05 00.

END OF SECTION 27 05 43

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an "end-to-end" solution is provided by one of the "pre-approved" manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish "benchmark" products from one or more of the "pre-approved manufacturers". The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
   a. Carlon
   b. Eastern Wire + Conduit
   c. Maxcell
   d. Oldcastle

Table 1 - Outside Plant Infrastructure			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
1	Manhole Concrete 24"W x 72"L x 48"D	Oldcastle	2x6x4 Comm Vault
		*Other	Submit for approval
2	Standard Inner-duct (OSP) HDPE Single Wall with Pull Rope (1" or 1-1/4" dia per drawings)	Carlon	CF4X1C (1" dia.) CG4X1C (1-1/4" dia.)
		Carlon	DF4X1C (1" dia.) DG4X1C (1-1/4" dia.)
		Eastern Wire + Conduit	Kortech PDCN1000F
3	Fabric Mesh Inner-duct (3-cell for 4" conduit) - Alternate for (3) 1" OSP in 4" conduit	Maxcell	MXE86383
		*Other	Submit for approval

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

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Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FIT-OUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Structural, Mechanical, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 COMMUNICATIONS ROOM FIT-OUT

A. Communications Entrance Cabling Pathways

1. Inner Duct

a. Provide (3) 1-1/4-inch (31mm) outside plant rated fiber optic inner ducts in one or more conduits as indicated on the site plan, for incoming Communications service cabling.

B. Communications Backboard

1. Plywood Backboard:

a. Provide ¾-inch (19mm) AC grade plywood back board mounted on communications walls as noted on drawings.
b. Plywood shall be mounted “A” side out, “C” side to the wall.

c. Shall conform to UL FR-S Plywood 1780 R-7003

1) Shall be fire retardant impregnated plywood OR
2) Plywood shall be painted with fire rated intumescent paint on all sides.

d. Shall be painted to match architectural finish (white minimum), fire rated plywood must be painted with intumescent paint to maintain rating.
e. Ensure that UL listing and Fire Rating stamp are left unpainted to allow inspector to verify the rating of the plywood.
f. If the UL stamp is on the "C" side of the plywood, contractor shall document via install and material progress photographs, delivery manifests and UL listing certifications to help satisfy potential inspector comments.

C. Communications Cabinets, Racks, Frames and Enclosures

1. General

a. Provide Equipment Cabinet and/or Rack types and sizes as shown on Technology Drawings. Refer to specific rack types described below for additional information.
b. Cabinets and/or racks shall be completely setup and installed all locations.
c. Cabinets and/or racks shall be vertically and horizontally level.
d. Cable distribution equipment cabinets and racks shall utilize 19-inch Standard / ETSI wide rack system. Cabinets (if applicable) post depths shall be adjustable.
e. Rack Rail Width: 3-inch (75mm).
f. Rack Units: 42U (minimum).
g. Rack Material: 6061-T6 Aluminum.
h. Enclosure and/or Rack Finish: Black Epoxy Powder Coat.
i. Rack Mounting Holes: Pre-drilled and Threaded Tap Holes (spacing and diameter) or 3/8-inch (9.5mm) Square Punch with Cage Nuts per TIA standard pattern.
j. Vertical Cable Managers: Yes, as described within this specification.
k. Horizontal Cable Managers: Yes, as described within this specification.
l. Power Strips: Yes, as described within this specification.
m. Bonding and Ground. Yes, all cabinets and racks shall be grounded as described within Technology Drawings and specifications.
n. Cabinet Enclosure Electric Fan: Include as applicable per specified enclosure.

2. Equipment Cabinets – Server and/or Network Type:

a. Provide types and sizes as indicated on Technology Drawings.
b. Equipment Cabinet and Rack Specifications:

1) Enclosure Sizes: (as applicable per Technology Drawings)

a) 30"W x 42"D x 84"H (42U) (750mm x 1050mm x 2100mm).

2) Enclosure Doors: Perforated, Hinged (reversible), Removable, and Lockable.
3) Enclosure Side Panels: Solid (or Perforated), Removable and Lockable.

4) Enclosure Top Panel: Perforated with Cable Access.
5) Enclosure Material: Steel.
6) Enclosure Cable Access: Knockout Passages on Top and Back.
7) Rack Size: 19-inch W x 84-inch H (483mm x 2100mm).
8) Loading: 2000-lb (900kg).
9) Mounting Type: Freestanding on Floor with Adjustable Feet and Isolator Bushing.

3. Equipment Racks – 2-post Cable Distribution and Network Type:

a. Provide types and sizes as indicated on Technology Drawings.
b. Equipment Cabinet and Rack Specifications:

1) Enclosure: None.
2) Rack Type: 2-Post open frame rack, 19-inch TIA Standard.
3) Rack Size: 19” W x 84” H (42U) (483mm x 2100mm).
4) Loading: 1000-lb (450kg).
5) Mounting Type: Bolted to Floor with Neoprene Isolator.

4. Equipment Racks – Fiber Termination Rack:

a. Provide types and sizes as indicated on Technology Drawings.
b. Equipment Cabinet and Rack Specifications:

1) Enclosure: Frame
2) Rack Type: 4-Post open frame rack.
3) Rack Size:

a) 42”W x 12”D x 87”H (1050mm x 300mm x 2200mm)

4) Mounting Type: Bolted to the Floor with Neoprene Isolator.

D. Communications Termination Blocks and Patch Panels

1. All communications cables shall be terminated unless noted otherwise.
2. Cable terminations including wall fields, blocks, and patch panels are specified with in other sections.
3. Refer to 27 13 13 – Communications Copper Backbone Cabling, 27 13 23 – Communications Optical Fiber Backbone Cabling, and 27 15 01 – Communications Horizontal Cabling for additional requirements.

E. Communications Cable Management

1. General

a. Horizontal cable tray shall be mounted around room perimeter and above equipment racks as indicated on drawings. Tray sections shall be offset a minimum

of 6-inches (150mm) clear from wall (unless otherwise noted) to allow passage of other systems up wall including risers, backbone, and other distribution.

b. Vertical ladder rack shall be placed on wall above riser conduit locations to support tie off of backbone cables.
c. Cable Tray sections shall be bonded together for electrical continuity (grounding) and system bonded to telecommunications ground bus (TGB) or electrical ground bus. Ladder rack, hardware, and components shall be UL classified.
d. Cable Tray drop-outs shall be provided above all equipment racks and/or cabinets to allow for cable transition to termination panels.

2. Cable Tray – Ladder Type

a. Cable racking in Communications Rooms shall be ladder rack with ASTM A513 and A570 structural tubular steel complete with all required mounting hardware and with all fittings and cables needed to form a bonded (grounded).

1) Width: Refer to Technology Drawings.
2) Side rails: 1½-inch x 3/8-inch (150mm x 9.5mm)
3) Rungs: 9-inches (225mm) on-center
4) Finish: Yellow zinc dichromate.

3. Wall Field Cable Managers:

a. Jumper troughs and cable managers shall be provided along each side and between wall fields or any other wall mounted cable terminals or patch panels. This is to provide adequate support of cables interconnecting wall fields or other wall mounted cable terminals.

4. D-Rings:

a. D-Rings or equivalent means shall be provided as necessary on backboard to support any horizontal and vertical cables not supported by cable tray or other means.
b. Spacing shall not exceed 24-inches (600mm) or cable manufacturer's recommendation, whichever is less.

F. Communication Rack Mounted Power Protection and Power Strips

1. Rack Mounted Uninterruptible Power Systems (UPS)

a. A rack mounted UPS shall be provided by the project.
b. The UPS including battery requirements, rack enclosure and power connections are specified within another section.
c. Refer to 27 33 53 – Technology Uninterruptable Power Supply (UPS) for additional requirements.

2. Vertical Power Strips

    a. One (1) equipment cabinet shall be installed with (2) different vertical power strips that have multiple power outlets to connect equipment within cabinet.
    b. Power strips shall have a cord with plug and shall be connected to specific receptacles on dedicated circuits; (1) L6-30P, (1) L5-20P.
    c. Power strips shall be connected to different power sources or UPS wherever possible.
    d. Provide mounting brackets per cabinet and/or power strip manufacturer recommendations to properly mount power strips within cabinet.
    e. There may be various power strip types and configurations used on this project. Refer to Technology Drawings and product list for additional requirements.

3. Horizontal Power Strips

    a. Five (5) equipment cabinets shall be installed with (2) different horizontal power strips that have multiple power outlets to connect equipment within cabinet.
    b. Power strips shall have a cord with a plug and shall be connected to specific receptacles on dedicated circuits; (1) L6-30P, (1) L5-20P.
    c. There may be various power strip types and configurations used on this project. Refer to drawings and product list for additional requirements.

G. Telecommunications Grounding Busbar (TGB)

1. Each Communications Room shall be installed with a dedicated telecommunications ground bus bar (TGB) and bonded to the telecommunications bonding backbone (TBB).
2. Each Equipment Cabinet, Equipment Rack, Ladder Rack or Wire Basket Tray, Conduit Sleeves, and other metallic components etc. shall be individually bonded and grounded to TGB. Overhead Ladder Rack or Basket Tray may have a single grounding connection to the ground bus bar, but shall have grounding jumpers provided between each segment (as required) for tray that does not have connectors which are UL listed for grounding.
3. Refer to Section 27 05 26 – Telecommunications Grounding and Bonding for additional requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Equipment Cabinet and/or Rack Installation:

1. Cabinets and racks shall be vertically and horizontally level.
2. Provide a junction plate at top of equipment rack and required cable runway to attach rack to cable runway around the perimeter of the Communications room. Junction plate must be fastened to frame without using "J" hooks so that no equipment space is lost.
3. The completed equipment rack will be affixed to the floor using drop-in anchors and 5/8-inch zinc-plated hex bolts, split and flat washers.
4. All equipment and components noted in this section and drawings shall be provided and completely setup and installed. This includes but not limited to Cabinets and Racks, Cable Management and Ladder Rack, Communication Wall Fields and Patch Panels, and Communications Rack Mounted Power Protection and Power Strips.
5. All equipment shall be generally installed per drawings and field coordinated with current conditions and other trades. The final locations shall be coordinated with Owner, Architect, and Engineer prior to installation. No additional cost submitted by contractor shall be incurred by Owner due to Contractor's failure to comply with this requirement.

C. Drip Pans:

1. Drip Pans: Where possible to run mechanical piping elsewhere, do not run mechanical piping directly above technology work which is sensitive to moisture. If no other options exist and after confirmation review with Engineer and Owner, provide drip pans under mechanical piping, sufficient to protect technology work from dripping.
2. Locate pan immediately below piping, and extend a minimum of 6" on each side of piping and lengthwise 18" beyond equipment being protected.
3. Fabricate pans 2" deep of reinforced sheet metal with rolled edges and soldered or welded seams; 22 gauge galvanized steel. Provide ¾" copper drainage piping from pan to nearest floor drain or similar suitable point of discharge, and terminate pipe as an open-sight drainage connection.
4. Coordinate work with MEP Contractor.
5. Insulate bottom of pan and drainage pipe as directed by Engineer.

D. Labeling:

1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

END OF SECTION 27 11 00

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an "end-to-end" solution is provided by one of the "pre-approved" manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish "benchmark" products from one or more of the "pre-approved manufacturers". The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
   a. APC
   b. Chatsworth-CPI
   c. CommScope
   d. Hoffman
   e. Middle Atlantic
   f. Ortronics
   g. Panduit

Table 1 - Equipment Cabinets, Racks, and Accessories

Item	Part Name/Description	Manufacturer	Part Number
1	42U - Network Cabinet, Steel Vented Front Door, Double Vented Rear Doors, (30"W x40"D x79"H)	Tripp Lite	SR42UBWD
		*Other	Submit for approval
2	45U - 4-post Open Fiber Equipment Rack (42"W x12"Dx87"H)	CommScope	760243095 FACT-FRCCRHP22
3	45U - 2-post Equipment Rack (6-inch Channel)	Chatsworth-CPI	66353-703
		CommScope	RK6-45A
		Legrand / Ortronics	19-84-6T2SDB
4	Horizontal Power Distribution Unit (PDU) (L5-20P)	APC	AP7801B
		*Other	Submit for approval
5	Horizontal Power Distribution Unit (PDU) (L6-30P)	APC	AP7911B
		*Other	Submit for approval
6	Vertical Power Distribution Unit (PDU) (L5-20P)	APC	AP7530
		*Other	Submit for approval
7	Vertical Power Distribution Unit (PDU) (L6-30P)	APC	AP7541
		*Other	Submit for approval

Table 2 - Raceway and Accessories			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
1	12-inch Ladder Rack Type Cable Tray (Black Powder Coat Finish)	Chatsworth-CPI	11252-712
		CommScope	CR-SLR-10L12W
		Legrand / Ortronics	TRT10-12B
2	Ladder Rack Triangular Support Bracket Aluminum 18-inch Wide (Black)	Chatsworth-CPI	11312-718
		CommScope	CRTWSBK-18W
		Legrand / Ortronics	P139540HB
3	Ladder Rack Suspended Mount Support Bracket Aluminum 12-inch Wide (Black)	Chatsworth-CPI	12362-712
		CommScope	CRCMK5-8TR
		Legrand / Ortronics	RCBK-6
4	Ladder Rack to Equipment Rack Support Brackets - Elevation Kit (Black)	Chatsworth-CPI	10595-712
		CommScope	CRR2RRMK
		Legrand / Ortronics	REK-4-6
5	12-inch Ladder Rack Radius Drop Out (Cross Member - Black)	Chatsworth-CPI	14304-702
		CommScope	CRDK-12W
		Legrand / Ortronics	TRP11-CM
6	12-inch Ladder Rack Radius Drop Out (Stringer Member - Black)	Chatsworth-CPI	14305-700
		CommScope	CRSMCRDK
		Legrand / Ortronics	TRP8-S
7	Ladder Rack Butt-Splice Kit (Black)	Chatsworth-CPI	11301-701
		CommScope	CRBSK
		Legrand / Ortronics	P820127H

Table 2 - Raceway and Accessories			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
8	Ladder Rack Junction Splice Kit (Black)	Chatsworth-CPI	11302-701
		CommScope	CRTJSK
		Legrand / Ortronics	P820147H
9	Equipment Grounding Components	Chatsworth-CPI	40164-001
		CommScope	CRGND
		Legrand / Ortronics	GS-8

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 COMMUNICATIONS COPPER CABLING SYSTEM

A. Topology:

1. The Communications Copper Backbone Cabling will be an industry standard physical star topology with high pair count copper cabling interconnecting each Intermediate Cross-connect (IC) to the Copper Main Cross-Connect (MC) location, unless noted otherwise.
2. For conditions where backbone cable is provided to non-communication room locations, all cabling topology shall follow the same requirements and originate from the MC unless noted otherwise.
3. All cable splices shall be coordinated with Owner, Architect, and Engineer. This includes those shown on drawings and/or proposed by Contractor.
4. Cable splices are only acceptable as noted on the drawings and must be approved by Owner, Architect, and Engineer.
5. Cable splices are only intended where differing cable types are joined and/or multiple smaller cables are joined to a larger backbone feeder cables.
6. Splices are not acceptable to extend cables of inadequate length.
7. Refer to drawings for additional requirements.

B. General Requirements

1. All cable and terminations shall meet the minimum Performance and Criteria listed in specification below and on drawings, in accordance with TIA-568-C.2.
2. Cable requirements including cable types, quantities and pair / strand counts are specified on the drawings.
3. All cables shall have the appropriate fire spread rating per building codes, industry standard, and Underwriters Laboratory (UL/cUL) including plenum (CMP/OFNP/OFCP), riser (CMR/OFNR/OFCR), etc. The contractor shall verify the appropriate cable is being used for application it is installed.
4. Any cable routed below grade shall utilize specific water block construction. Copper cables generally use gel-filled compound to achieve this rating. The contractor is required to submit a solution wherever this condition exists regardless of whether noted on drawings.
5. Underground rated cable that doesn't carry a suitable indoor building cable rating per building code and UL, shall not be routed more than 50-ft (15m) inside the building. Cable shall be spliced or terminated as appropriate and noted on drawings.
6. All armored and/or metallic cable sheaths shall be bonded to Telecommunications Ground Bus (TGB).

C. Performance and Criteria

1. General Copper Backbone Cabling Requirements: (as applicable per drawings)

    a. Cable Rating:

        1) Riser Rated

    b. Cable Construction:

        1) Construction: Unshielded Twisted Pair
        2) Medium: Solid Annealed Copper

    c. Length Limitations: 2600-feet (800m) for telecommunications
    d. Physical Specification:

        1) Standard Cable Sizes: 25, etc. per one-line drawings.
        2) Conductor Size: 24 AWG

    e. Compliances: Refer to respective cables types in section 2.2.
    f. Electrical Specifications:

        1) Characteristic Impedance: 100 Ohms
        2) Cat.3 Frequency: 1-16 MHz

g. Temperature:

1) CMP Operating and storage: -4 to +140F (-10 to +60C)
2) OSP Operating and storage: -40 to 158F (-40 to +70C)

h. Pulling Tensions (max): 25-lb (11 kg).
i. Transmission Performance (min.)

1) Refer to tables below for each applicable cable type.

2. Category 3 Telecommunications

a. Transmission Performance (min.)

1) Permanent Link

CATEGORY 3 - PERMANENT LINK		
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	3.5	40.1
4.0	6.2	30.7
8.0	8.9	25.9
10.0	9.9	24.3
16.0	13.0	21.0

2) Channel

CATEGORY 3 - CHANNEL		
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	4.2	39.1
4.0	7.3	29.3
8.0	10.2	24.3
10.0	11.5	22.7
16.0	14.9	19.3

3) Connecting Hardware

CATEGORY 3 - CONNECTING HARDWARE		
Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)
1.0	3.5	40.1
4.0	6.2	30.7
8.0	8.9	25.9
10.0	9.9	24.3
16.0	13.0	21.0

4) Assembled Patch Cord
   a) Use Category 5E requirements if patch cords are used rather than cross-connect jumpers.

CATEGORY 5E – ASSEMBLED PATCH CORD				
Frequency (M Hz)	**2 m Cord NEXT (dB)**	**5 m Cord NEXT (dB)**	**10 m Cord NEXT (dB)**	**Return Loss (dB)**
1.0	65.0	65.0	65.0	19.8
4.0	62.3	61.5	60.4	21.6
8.0	56.4	55.6	54.7	22.5
10.0	54.5	53.7	52.8	22.8
16.0	50.4	49.8	48.9	23.4
20.0	48.6	47.9	47.1	23.7
25.0	46.7	46.0	45.3	24.0
31.25	44.8	44.2	43.6	23.0
62.5	39.0	38.5	38.1	20.0
100.0	35.1	34.8	34.6	18.0
Attenuation: per 100 meters (328-feet) @20 C=Horizontal UTP Cable Attenuation + 20%(due to Standard Conducts)				

2.2 CABLE REQUIREMENTS

A. General

1. The cables shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on TIA-568-C.2 equivalent cable rating.
2. Refer to Technology Drawings for all cable types, quantities and pair / strand counts.

B. Cat. 3 Riser Rated – Telecommunications Cables

1. Application: Building backbone and riser installation within duct, conduits or cable trays telecommunications backbone cable.
2. Construction:

   a. Insulation: Flame retardant semi-rigid PVC.
   b. Shield/Sheath: None.
   c. Filling Compound: None.
   d. Jacket: Flame retardant PVC.

3. Color: Gray.
4. Compliances: TIA-568-C.2, NEC/CEC Type CMR.

C. Cat. 3 Plenum Rated – Telecommunications Cables

2.3 TERMINATION REQUIREMENTS

A. General

1. Wiring terminals shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type, based on TIA-568-C.2 equivalent cable ratings.
2. Provide all necessary wiring terminals, jumper troughs, protector panel, ground wire and bonding to building ground, and plug in protectors (as applicable).
3. Temperature rating (unless noted otherwise):

    a. Operating: +14 to +140 OF (-10 to +60 OC).
    b. Storage: -40 to +158 ^{O}F (-40 to +70 ^{O}C).

B. Protector Panel and Building Entrance Terminal

1. General:

    a. All copper service entrance pairs serving the building shall be terminated on a Protector Panel and Building Entrance Terminal.
    b. All copper cable pairs routed to the exterior or routed to locations outside of building footprint shall be terminated on a Protector Panel at each end.

2. Type: 195-Type.
3. Mounting Configuration: Wall Mounted.
4. Protection: Ground Fault and Sneak Current.
5. Size: 100-Pair (and as required).
6. Cable Interface:

    a. Input: 110-Type Wiring Block or RJ21X Connector.
    b. Output: 110-Type Wiring Block or RJ21X Connector.

7. Protectors: Gas Discharge Tube (or Solid State) 5-Pin Plug In Protector (PIP).
8. Electrical Specifications:

    a. TIA: Category 3
    b. UL and cUL Listed
    c. FCC Part 68

C. 110-Type Wiring Blocks

1. Type: 110-Type w/ Legs.
2. Mounting Configuration: Wall Mounted (or 19-inch Rack).
3. Size: 100-Pair or 300-Pair (and provided as required to terminate all cable).
4. Cable Interface:

    a. Input: 110-Type Wiring Block.

b. Output: 110-Type Wiring Block.

1) 5-Pin Connector for feeder cables greater than 4-pairs.
2) 4-Pin Connector for 4-pair cables.

5. Electrical Specifications:

a. TIA: Category 5E
b. Insulation Resistance: 500 MegaOhms (minimum).
c. Current Rating: 1.5A @68 ^{O}F (20 ^{O}C).
d. Dielectric Withstand Voltage: 1000 VAC RMS, 60Hz (minimum), contact-to-contact and 1,500 VAC RMS, 60Hz (minimum) to exposed conductive surface.
e. UL and cUL Listed
f. FCC Part 68

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Labeling:

1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Each cable, wiring block, patch panel, and termination shall be identified at the Main Cross-connect (MC), at the Intermediate Cross-connect (IC), and at each station termination.
3. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

C. Telecommunications Testing:

1. All communications copper backbone cabling and pairs shall be tested for electrical continuity and wire map.
2. All cabling will be test/certified for conformance to the TIA-568-C.2 Category 3 and Category 5 specifications (as applicable) using Level 2 test equipment in accordance with TIA-568-C.2.
3. Cable tests will be per industry standard and also include the following:

a. Cable Length
b. Attenuation
c. NEXT
d. Characteristic Impedance

e. Mutual Capacitance
f. Resistance
g. Noise
h. Wire Map

4. Electronic test results shall be submitted by the Contractor for approval by Owner, Architect, and Engineer.

END OF SECTION 27 13 13

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an "end-to-end" solution is provided by one of the "pre-approved" manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish "benchmark" products from one or more of the "pre-approved manufacturers". The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
   a. Circa
   b. CommScope (Systimax)
   c. General / Panduit
   d. Superior Essex / Ortronics
   e. tii

Table 1 - Copper Backbone Cable / Connectivity Products			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
1	25-pair Category 3 - Riser Rated Cable	CommScope	1010A WH 25/24
		Superior Essex	18-025
		General Cable	2131505
2	Building Entrance Terminal Protector with 110 in and 110 out terminations, 100 pair	Circa	1880ECA1-25
		tii	24025-110-M110C
3	110-Style Termination Block (100-pair with legs)	CommScope Systimax	107058901 110AA2-100FT
		Ortronics	OR-110ABC100
		Panduit	P110KB1004Y
4	110-Block Rack Mounting Frames	CommScope Systimax	104405113 188B2
		Ortronics	OR-30600167
		Panduit	P110B100R2BY
5	4-pair 110C connecting blocks	CommScope Systimax	103801247 110C-4
		Ortronics	OR-30200109
		Panduit	P110CB4-XY

Table 1 - Copper Backbone Cable / Connectivity Products			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
6	Cross-connect Wire Retainer	CommScope Systimax	107831133 110A3
		Ortronics	
		Panduit	P110JTW-X
7	110-block Labeling Components	CommScope Systimax	106657133 110WA2-4500L
		Ortronics	OR-70400646
		Panduit	C750X050Y1J

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING SYSTEM

A. Topology:

1. The Optical Fiber Backbone Cabling will be an industry standard physical star topology with fiber optic cabling interconnecting each Intermediate Cross-connect (IC) to the Fiber Optic Main Cross-Connect (MC) location, unless noted otherwise.
2. For conditions where backbone cable is provided to non-communication room locations such as Remote Hub locations, all cabling topology shall follow the same requirements and originate from the MC unless noted otherwise.
3. All cable splices shall be coordinated with Owner, Architect, and Engineer. This includes those shown on drawings and/or proposed by Contractor.
4. Cable splices are only acceptable as noted on the drawings and must be approved by Owner, Architect, and Engineer.
5. Cable splices are only intended where differing cable types are joined and/or multiple smaller cables are joined to a larger backbone feeder cables.
6. Splices are not acceptable to extend cables of inadequate cable lengths.
7. Refer to drawings for additional requirements.

B. General Requirements:

1. All cable and terminations shall meet the minimum Performance and Criteria listed in specification below and on drawings, in accordance with TIA-568-C.3.
2. Cable requirements including cable types, quantities and pair / strand counts are specified on the drawings.
3. All cables shall have the appropriate fire spread rating per building codes, industry standard, and Underwriters Laboratory (UL/cUL) including plenum (CMP/OFNP/OFCP), riser (CMR/OFNR/OFCR), etc. The contractor shall verify the appropriate cable is being used for application it is installed.
4. Any cable routed below grade shall utilize specific water block construction. Fiber optic cables can use dry water block tape or gel-filled compound to achieve this rating. The contractor is required to submit a solution wherever this condition exists regardless of whether noted on drawings.
5. Underground rated cable that doesn't carry a suitable indoor building cable rating per building code and UL, shall not be routed more than 50-ft (15m) inside the building. Cable shall be spliced or terminated as appropriate and noted on drawings.
6. Approved splices shall be low attenuation fusion type.
7. All armored and/or metallic cable sheaths shall be bonded to Telecommunications Ground Bus (TGB).
8. Fiber terminations shall swap transmit/receive polarity on far end of cable per industry standards for all mated or duplex connectors. This requirement shall be coordinated with Owner and Facility Operator.
9. Service loops shall be provided at each end of cable at the termination point.
10. Provide breakout or fan-out kits for all loose type fiber optic cables for transitioning to tight buffered cable at termination points.

C. Performance and Criteria:

1. General Fiber Backbone Cabling Requirements: (as applicable per drawings)

    a. Cable Rating:

        1) Outside Plant / Underground w/ Water Block
        2) Riser Rated
        3) Plenum Rated
        4) Indoor / Outdoor

    b. Cable Construction:

        1) Construction: Interlocking Armored and/or Non-Armored

    c. Length Limitations: Refer to tables below.
    d. Physical Specification:

        1) Strand Counts: 24, 48 and 96.
        2) Multi-mode Core Diameter: 50-Micron

3) Single-mode Core Diameter: 8-Micron
4) Cladding Diameter: 125-Micron

e. Compliances: Refer to respective cables types in section 2.2.
f. Temperature:

1) CMP Operating and storage: -4 to +140F (-10 to +60C)
2) OSP Operating and storage: -40 to 158F (-40 to +70C)

g. Bend Radius (Minimum):

1) Installation: 20X Outside Cable Diameter.
2) Operating: 10X Outside Cable Diameter.

h. Pulling Tensions (max): 25-lb (11 kg).
i. Transmission Performance (min.)

1) Refer to tables below for each applicable cable type.

2. 50.0 – Micron Multi-Mode 300 (OM3)

a. Transmission Performance:

50.0 - MICRON MULTI-MODE (OM3)						
Wavelength	Maximum Attenuation	Bandwidth (MHz-km)	Supported Ethernet Length			
			10 Mbps	100 Mbps	1 Gbps	10Gbps
850 nm	3.5 dB/km	2000 MHz-km	980-feet (300m)	980-feet (300m)	3280-feet (1000m)	980-feet (300m)
1300 nm	1.5 dB/km	500 MHz-km	6560-feet (2000m)	6560-feet (2000m)	1960-feet (600m)	980-feet (300m)

3. 50.0 – Micron Multi-Mode 550 (OM4)

a. Transmission Performance:

50.0 - MICRON MULTI-MODE (OM4)						
Wavelength	Maximum Attenuation	Bandwidth (MHz-km)	Supported Ethernet Length			
			10 Mbps	100 Mbps	1 Gbps	10Gbps
850 nm	3.5 dB/km	4700 MHz-km	980-feet (300m)	980-feet (300m)	3600-feet (1100m)	1800-feet (550m)
1300 nm	1.5 dB/km	500 MHz-km	6560-feet (2000m)	6560-feet (2000m)	1960-feet (600m)	980-feet (300m)

4. 8.3 – Micron Single-Mode (SM2/OS2)

a. Transmission Performance:

8.3 - MICRON SINGLE-MODE, (OS2)						
Wavelength	Maximum Attenuation	Bandwidth (MHz-km)	Supported Ethernet Length			
			10 Mbps	100 Mbps	1 Gbps	10Gbps
1310 nm	0.5 dB/km	100 TeraHz-km	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)
1550 nm	0.5 dB/km	100 TeraHz-km	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)	9800-feet (3000m)

2.2 CABLING

A. General

1. This cable shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on ANSI/TIA/EIA-568-C.3 equivalent cable rating.
2. Refer to Technology Drawings for all cable types, quantities and pair / strand counts.

B. Interlocking Armored Building Cables

1. Riser Rated (CMR / OFCR)

a. Application:

1) Building Cable is intended for interior building backbone and riser distribution installation within duct, conduits, and/or cable tray.

b. Construction:

1) Jacket: Flame Retardant, Riser Rated, (CMR / OFNR)
2) Fiber Buffer: Tight Buffered, 900-micron.
3) Armor: Interlocking Aluminum.
4) Strength Member: Aramid Strength Yarn.
5) Water Block/Filling Compound: None.

c. Compliances:

1) ANSI/TIA/EIA-568-C.3
2) NEC/CEC Type CMR / OFCR.

C. Non-Armored Building Cables

1. Plenum Rated (CMP / OFNP)

a. Application:

1) Building Cable is intended for interior building backbone and riser distribution installation within duct, conduits, and/or cable tray. Requires installation within inner-duct to protect cable.

b. Construction:

1) Jacket: Flame Retardant, Plenum Rated, (CMP / OFNP)
2) Fiber Buffer: Tight Buffered, 900-micron.
3) Armor: None.
4) Strength Member: Aramid Strength Yarn.
5) Water Block/Filling Compound: None.

c. Compliances:

1) ANSI/TIA/EIA-568-C.3
2) NEC/CEC Type CMP / OFNP.

D. Indoor/Outdoor Interlocking Armored Building Cables

1. Riser Rated (CMR / OFCR)

a. Application:

1) Indoor/Outdoor Building Cable is intended for interior, exterior and outdoor building backbone and riser distribution installation within duct, conduits, and/or cable tray.

b. Construction:

1) Jacket: Flame Retardant, Riser Rated, (CMR / OFNR)
2) Fiber Buffer: Tight Buffered, 900-micron.
3) Armor: Interlocking Aluminum.
4) Strength Member: Aramid Strength Yarn.
5) Water Block/Filling Compound: Yes, Water Block Construction.

c. Compliances:

1) ANSI/TIA/EIA-568-C.3
2) NEC/CEC Type CMR / OFCR.

E. Outside Plant (OSP) Cables

1. Loose Tube Interlocking Armored OSP Cables

a. Application:

1) Underground duct
2) Trunk, distribution and feeder cable
3) Local loop, metro, long-haul and broadband network

b. Construction:

1) Jacket: UV resistant
2) Fiber Buffer: Loose Buffered
3) Armor: Corrugated steel interlocking
4) Strength Member: Central and dielectric water-blocking
5) Water Block/Filling Compound: Gel (PFM or generic)

c. Compliances:

1) Telcordia GR-20-CORE
2) RDUP PE-90 Designation MLT
3) ICEA S-87-640-2006
4) RoHS-compliant

2.3 TERMINATION EQUIPMENT

A. General

1. Fiber terminations shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type, based on ANSI/TIA/EIA-568-C.3 equivalent cable ratings.
2. Provide all necessary fiber enclosures, splice trays, and connectors (as applicable). Refer to Technology Drawings for additional information.

B. Termination Type Requirements

1. Pre-terminated fiber module with pigtail for fusion splicing, mounted within splice tray.

C. Connectors

1. General:

a. Ferrule: Ceramic
b. Fiber Buffer Size: 900-micron
c. Optical Specification:

1) Multi-mode
2) Single-mode
3) Insertion Loss (Typical / Max.): <0.3dB / <0.75dB

d. Plug Requirements:

1) Retention Force (Buffer): 2-lb (0.9kg)
2) Retention Force (Cordage): 10-lb (4.5kg)
3) Insertion Life: 500 minimum.

e. Temperature rating (operating): -40 to +167 ^{O}F (-40 to +75 ^{O}C).

2. LC-Type

a. Application / Fiber Type:

1) Multi-mode
2) Single-mode

b. Form Factor: Small Form Factor (SFF)
c. Adapter Type: Duplex
d. Form Factor: Small Form Factor (SFF)

3. SC-Type

a. Application / Fiber Type:

1) Single-mode

b. Adapter Type: Duplex
c. Form Factor: Small Form Factor (SFF)
d. Polish: Angled Polished Connectors (APC)

D. Enclosures

1. General:

a. Use: Enclosure or housing for consolidating connectors and/or splicing of high density optical fiber typically at communication distribution and equipment rooms.
b. Mounting Configuration: FACT Frame
c. Cable Managers:

1) Internal strand managers for service loops and strand management in back side.
2) Internal patch cord manager at front side.
3) Cable access on both sides at front and back sides. Access points should have integrated curved guards to support appropriate cable bends.

2. Element – Rack Mount Fiber Optic Housing

a. Application: Fiber Optic Rack mount fiber terminations.
b. Size: Element size 1E, 2E, 3E, 6E

E. Splice Trays

1. General:

a. Shall meet the minimum requirements noted in Performance and Criteria Section.
b. Dedicated splice trays may not be necessary as enclosures with built in splice trays may be acceptable, if submitted and accepted by Owner / Engineer.

2. Application:

a. Provide protection and slack management of heat shrink fusion spliced fibers.
b. Splice tray to be used with enclosures noted below.

3. Fiber Types supported:

    a. Micron Multi-Mode (OM3, OM4)
    b. Micron Single-Mode (OS1, SM2)

4. Related components to be provided (as necessary):

    a. Mounting hardware kits
    b. Heat shrink splice sleeve (40mm and/or 60mm lengths)

2.4 PATCH CORDS

A. General Requirements:

1. The patch cords shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on ANSI/TIA/EIA-568-C.3 equivalent cable rating.
2. Patch cords shall be provided as part of project at main cross-connects, intermediate cross-connects, and horizontal cross-connects (as applicable).
3. All fiber optic patch cords shall be from the same manufacturer as the fiber optic backbone and shall meet all performance requirements established in earlier sections of this specification.
4. Lengths and Colors: Refer to Technology Drawings (symbol legend) for additional requirements on various patch cord lengths and/or colors.
5. When provided by Contractor, patch cords to be provided for all fiber and connector types included in project, per sections 2.1, 2.2, and 2.3 of this specification section.
6. Refer to Technology Drawings (symbol legend) for additional requirements on various patch cord types, lengths and/or colors.

2.5 MISCELLANEOUS COMPONENTS

A. Grounding Components:

1. All fiber optic cabling with metallic sheath (i.e. Interlocking Armored Fiber) shall be grounded at each end, if cable exits the room.
2. Provide armored fiber jacket grounding straps grounded to telecom grounding busbar or ladder rack (not equipment rack), per manufacturer recommendations.

2.6 PATHWAYS

A. Inner-Duct:

1. Provide appropriately rated fiber optic inner-duct for incoming service conduits and any locations where non-armored fiber optic cable is installed. Refer to Technology Drawings for additional information, but inner-duct rating types used on this project may include:

    a. Outside Plant
    b. Interior Riser Rated

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Grounding:

1. All fiber optic cabling with metallic sheath (i.e. Interlocking Armored Fiber) shall be grounded at each end per manufacturer recommendations, if cable exits the room.
2. Refer to Telecommunications Grounding and Bonding specification section 27 05 26 for additional requirements.

C. Labeling:

1. The final labeling scheme shall be coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Each cable, termination panel, and termination shall be identified at the Main Cross-connect (MC), at the Intermediate Cross-connect (IC), and at each station termination.
3. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

D. Fiber Optic Testing/Certification (Passive)-EIA/TIA-526-14

1. Multi-mode Fiber:

    a. All fiber optics will be tested for end-to-end attenuation at 850nm and 1300nm; using an optical power source and an optical power meter.
    b. Tests will be performed after connectors have been installed, and will be from jumper side of hub(s) bulkhead connector to the jumper side of the bulkhead connectors at the MC/IC fiber interconnect panel.
    c. Maximum loss will not exceed manufacturers' passive cable system attenuation; adjusted for cable length connector loss.
    d. Maximum connector pair loss is .5dB. Splices are not acceptable in this system.

e. Test results, including OTDR printouts, will be included in the final documentation package.
f. Contractor shall complete a fiber optic post installation report at the time of testing containing meter readings at both 850 nm and 1300 nm from both directions on each fiber. Report shall include actual loss and other pertinent data regarding the cables tested, including model and serial number of test equipment, cable part number, installed fiber length, building span loss at 850 nm and 1300 nm and date tested.
g. Span loss calculations are required on the final test sheet for loss at 850 nm and 1300 nm for multimode.

(D x L) + (C x # connectors)
D = Length; L = Loss; C = Connector loss (Max 0.75 dB)
1 ft. = 0.0003048 km.

2. Single-mode Fiber:

a. All fiber Optics will be tested for end-to-end attenuation at both 1310nm and 1550nm; using an optical power source and an optical power meter.
b. Tests will be performed after connectors have been installed, and will be from jumper side of the hub(s) bulkhead connector to the jumper side of the bulkhead connectors at the MC/IC fiber interconnect panel.
c. Maximum loss will not exceed manufacturer's passive cable system attenuation; adjusted for cable length and connector loss.
d. Maximum connector pair loss is 0.5 dB. Splices are not acceptable in this system.
e. Test results including OTDR printouts will be included in the final documentation package.
f. Contractor shall complete a fiber optic post installation report at the time of testing containing meter readings at both 1310nm and 1550nm from both directions on each fiber. Report shall include actual loss and other pertinent data regarding the cables tested, including model and serial number of test equipment, cable part number, installed fiber length, building span loss at 1310nm and 1550nm and date tested.
g. Span loss calculations are required on the final test sheet for loss at 1310nm and 1550nm for single-mode.

(D x L) + (C x # connectors)
D = Length; L = Loss; C = Connector loss (Max 0.75 dB)
1 ft. = 0.0003048 km.

END OF SECTION 27 13 23

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an "end-to-end" solution is provided by one of the "pre-approved" manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish "benchmark" products from one or more of the "pre-approved manufacturers". The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
   a. CommScope (Systimax)
   b. Belden
   c. Superior Essex / Ortronics

Table 1 - Fiber Optic Cables			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
1	OM4 Multi-mode (OFNP) Plenum Rated Premises Cable (Non-Armored)	CommScope	P-XXX-DS-5K-FSUAQ
		Superior Essex	44XXXPG
		Belden	FI4DxxxP9A
2	OM4 Multi-mode (OFCR) Riser Rated Premises Cable (Armored)	CommScope	R-XXX-DZ-5K-FSUAQ
		Superior Essex	L3XXXP
		Belden	FI4DxxxF9
3	OS2 (G657.A1) Single-mode (OFNP) Plenum Rated Premises Cable (Non-Armored)	CommScope	P-XXX-DS-8W-FSUYL
		Superior Essex	44XXXK
		Superior Essex	44XXXK1
		Belden	FISDxxxP9
4	OS2 (G657.A1) Single-mode (OFCR) Riser Rated Premises Cable (Armored)	CommScope	R-XXX-DZ-8W-FSUYL
		Superior Essex	L3XXXK
		Belden	FISDxxxF9

Table 1 - Fiber Optic Cables			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
5	OS2 (G657.A1) Single-mode (OSP) Outside Plant Loose Tube Cable (Armored)	CommScope	D-XXX-LA-8W-F12NS
		Superior Essex	12xxxKD01
		Belden	FSSLxxx6D
6	12A Grounding Clamp (for Armored Fiber)	CommScope	GAK-FEC001
		Legrand / Ortronics	Submit for Approval

Table 2 - Fiber Optic Connectivity Products			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
1	High Density 1U modular cassette sliding Panel, accepts (4) G2 modules or MPO panels, providing up to 48 duplex LC ports, or up to 32 MPO ports	CommScope	760209940 HD-1U
2	G2 ULL Singlemode MPO-12 Distribution Module, 24LC to 2X12f MPOs unpinned, internal shutters	CommScope	760238083 DM12-24LC-SM-ULL
3	FACT™ Fiber Optic Patch/Splice Panel, gray, 1E high, 24-port, singlemode, loaded with SC/APC adapters and C-grade pigtails, SMOUV splice tray type, right-hand patch	CommScope	760240005 FACT-1ERHPS2S
4	FACT™ Fiber Optic Patch/Splice Panel, gray, 2E high, 96-port, singlemode, loaded with LC/UPC adapters and C-grade pigtails, SMOUV splice tray type, right-hand patch	CommScope	760240020 FACT-2ERHPL1S
5	FACT™ Fiber Optic Patch/Splice Panel, gray, 3E high, 144-port, singlemode, loaded with LC/UPC adapters and C-grade pigtails, SMOUV splice tray type, right-hand patch	CommScope	760240027 FACT-3ERHPL1S
6	FACT™ Fiber Optic Patch/Splice Panel, gray, 1E high, 48-port, multimode, OM4, loaded with LC/UPC adapters and pigtails, SMOUV splice tray type, right-hand patch	CommScope	760240589 FACT-1ERHPL4S
7	FACT™ Fiber Optic Patch/Splice Panel, gray, 2E high, 48-port, singlemode, loaded with SC/APC adapters and C-grade pigtails, SMOUV splice tray type, right-hand patch	CommScope	760240605 FACT-2ERHPS2S

Table 2 - Fiber Optic Connectivity Products			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
8	FACT™ NG4 Fiber Panel, with 12 unloaded trays, gray, 6E high, for holding 24 NG4 adapter packs or 24 NG4 MPO modules or 12 NG4 cabled LC/SC modules or 12 NG4 value added modules	CommScope	760242087 FACT-6ENG4
9	Trunk fitting kit with 12 cable glands	CommScope	760242679
10	FACT™ cable termination unit (CTU), kit for 1E FACT chassis, accomodates: 1 cable 2.5-14mm or 2 cables 2.5-8.5mm or 4 cables 2.5-5mm or 1 flex tube OD 16mm, only for use in FACT frame	CommScope	760243102 FACT-FRACCCTU1E
11	FACT™ cable termination unit (CTU), kit for 2E FACT chassis, accomodates: 1 cable 2.5-14mm or 2 cables 2.5-8.5mm or 4 cables 2.5-5mm or 1 flex tube OD 16mm, only for use in FACT frame	CommScope	760243103 FACT-FRACCCTU2E
12	FACT™ cable termination unit (CTU), kit for 3E FACT chassis, accomodates: 1 cable 2.5-14mm or 2 cables 2.5-8.5mm or 4 cables 2.5-5mm or 1 flex tube OD 16mm, only for use in FACT frame	CommScope	760243104 FACT-FRACCCTU3E
13	FACT™ cable termination unit (CTU), kit for 6E FACT chassis, accomodates: 1 cable 2.5-14mm or 2 cables 2.5-8.5mm or 4 cables 2.5-5mm or 1 flex tube OD 16mm, only for use in FACT frame	CommScope	760243107 FACT-FRACCCTU6E
14	FACT™ MPO Module, left sided, LC/UPC at front side, 2x12 fiber MPO at rear side, singlemode, wiring method B Enhanced	CommScope	760244558 FACT-MMDLKE-B
15	Ultra Low Loss (ULL) Singlemode MPO12 (male) to MPO12 (male), Fiber Trunk Cable Assembly, 24-Fiber, Plenum, 30, ft, J - Yellow, A - 33 inch breakout (end A/end B), no gland, no pulling grip	CommScope	UGGMXMXAF-JAF030

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

F. Rough carpentry is specified in a Division 6 section.

PART 2 - SYSTEM REQUIREMENTS

2.1 HORIZONTAL STRUCTURED CABLING SYSTEM

A. Topology

1. The Communications Horizontal Cabling will be an industry standard physical star topology with cabling routed to each communication device outlet location from the nearest Horizontal Cross-connect (HC) location, unless noted otherwise.
2. Communications horizontal cabling shall not exceed a total cable length of 295-feet (90m) for the permanent basic link. The channel length shall not exceed 325-feet (100m) when patch cords are installed.
3. Contractor(s) responsible for providing the communications horizontal raceway and/or cabling shall ensure that the pathway and cable to each device location does not exceed 295-feet (90m) length back to the nearest HC location. Contractor shall bring any distance concerns to the attention of the Architect and Engineer during the bid process and/or at a minimum during the shop drawing process, prior to installation.
4. Contractor shall immediately notify Owner, Architect, and Engineer of any cable segment that exceeds the length limitation.
5. Refer to drawings for additional requirements.

B. General Requirements

1. All cable and terminations shall meet the minimum Performance and Criteria listed in specification below and on drawings.
2. Cable requirements including cable quantities are specified on the drawings.
3. All cables shall have the appropriate fire spread rating per building codes, industry standard, and Underwriters Laboratory (UL/cUL) including plenum (CMP/OFNP/OFCP), riser (CMR/OFNR/OFCR), etc. The contractor shall verify the appropriate cable is being used for application it is installed.
4. Any cable routed outside and/or below grade shall utilize specific water block construction. Cables generally use gel-filled compound to achieve this rating for copper cable and dry water block paper for others. The contractor is required to submit an Outdoor Rated and/or Underground Rated solution wherever this condition exists regardless of whether noted on drawings.
5. Outdoor Rated and/or Underground Rated cable that doesn't carry a suitable building cable rating per building code and UL, shall not be routed more than 50-ft (15m) inside the building. Cable shall be spliced or terminated as appropriate and noted on drawings.
6. Cabling system shall be procured from a single manufacturer that offers a complete end-to-end certified and warranted system for the TIA-568-C.2 Category noted for each system. Additionally, all products provided shall be the newest products offered by the manufacturer for the product category specified.
7. Cable splices of any kind are not acceptable for communications horizontal cabling system.
8. Cables from different low voltage systems (ex. 70v Speaker, BMS, etc.) shall not be run in the same conduit pathways unless specifically noted on the drawings.

C. Performance and Criteria

1. General Horizontal Cabling Requirements:

   a. Cable Rating:

      1) Plenum Rated (CMP).
      2) Riser Rated (CMR) or General Rated (CM) when installed in continuous conduits or non-plenum spaces as determined by Authority Having Jurisdiction (AHJ).
      3) Outdoor Rated (all outdoor or below grade applications).

   b. Cable Construction:

      1) Type: Unshielded Twisted Pair.
      2) Medium: Solid Annealed Copper.

   c. Length Limitations:

      1) 295-feet (90m).

d. Physical Specification

1) Standard Cable Sizes: 4-pairs.
2) Conductor Size: 24 AWG.

e. Compliances:

1) TIA-568-C.2,
2) NEC/CEC Type CMP.

f. Electrical Specification

1) Characteristic Impedance: 100 Ohms.
2) Cat.6 Frequency: 1-250 MHz.

g. Temperature:

1) CMP Operating and storage: -4 to +140F (-10 to +60C)
2) OSP Operating and storage: -40 to 140F (-40 to +60C)

h. Pulling Tensions (max): 25-lb (11 kg).
i. Transmission Performance (min.)

1) Refer to tables below for each applicable cable type.

2. Category 6

a. Transmission Performance (min.)

1) Permanent Link

CATEGORY 6 – PERMANENT LINK						
Frequency (M Hz)	**Insertion Loss (dB)**	**NEXT (dB)**	**PSNEXT (dB)**	**ELFEXT (dB)**	**PSELFEXT (dB)**	**Return Loss (dB)**
1.0	1.9	65.0	62.0	64.2	61.2	19.1
4.0	3.5	64.1	61.8	52.1	49.1	21.0
8.0	5.0	59.4	57.0	46.1	43.1	21.0
10.0	5.5	57.8	55.5	44.2	41.2	21.0
16.0	7.0	54.6	52.2	40.1	37.1	20.0
20.0	7.9	53.1	50.7	38.2	35.2	19.5
25.0	8.9	51.5	49.1	36.2	33.2	19.0
31.25	10.0	50.0	47.5	34.3	31.3	18.5
62.5	14.4	45.1	42.7	28.3	25.3	16.0
100.0	18.6	41.8	39.3	24.2	21.2	14.0
200.0	27.4	36.9	34.3	18.2	15.2	11.0

CATEGORY 6 – PERMANENT LINK						
Frequency (M Hz)	**Insertion Loss (dB)**	**NEXT (dB)**	**PSNEXT (dB)**	**ELFEXT (dB)**	**PSELFEXT (dB)**	**Return Loss (dB)**
250.0	31.1	35.3	32.7	16.2	13.2	10.0
Minimum Link Propagation Delay: 498ns @10MHz Maximum Link Delay Skew: 44ns/100m @10MHz						

2) Channel

CATEGORY 6 – CHANNEL						
Frequency (M Hz)	**Insertion Loss (dB)**	**NEXT (dB)**	**PSNEXT (dB)**	**ELFEXT (dB)**	**PSELFEXT (dB)**	**Return Loss (dB)**
1.0	2.1	65.0	62.0	63.3	60.3	19.0
4.0	4.0	63.0	60.5	51.2	48.2	19.0
8.0	5.7	58.2	55.6	45.2	42.2	19.0
10.0	6.3	56.6	54.0	43.3	40.3	19.0
16.0	8.0	53.2	50.6	39.2	36.2	18.0
20.0	9.0	51.6	49.0	37.2	34.2	17.5
25.0	10.1	50.0	47.3	35.3	32.3	17.0
31.25	11.4	48.4	45.7	33.4	30.4	16.5
62.5	16.5	43.4	40.6	27.3	24.3	14.0
100.0	21.3	39.9	37.1	23.3	20.3	12.0
200.0	31.5	34.8	31.9	17.2	14.2	9.0
250.0	35.9	33.1	30.2	15.3	12.3	8.0
Minimum Link Propagation Delay: 555ns @10MHz Maximum Link Delay Skew: 50ns/100m @10MHz						

3) Connecting Hardware

CATEGORY 6 – CONNECTING HARDWARE				
Frequency (M Hz)	**Insertion Loss (dB)**	**NEXT (dB)**	**FEXT (dB)**	**Return Loss (dB)**
1.0	0.10	75.0	75.0	30.0
4.0	0.10	75.0	71.1	30.0
8.0	0.10	75.0	65.0	30.0
10.0	0.10	74.0	63.1	30.0
16.0	0.10	69.9	59.0	30.0
25.0	0.10	66.0	55.1	30.0
31.25	0.11	64.1	53.2	30.0
62.5	0.16	58.1	47.2	28.1
100.0	0.20	54.0	43.1	24.0

CATEGORY 6 – CONNECTING HARDWARE				
Frequency (M Hz)	**Insertion Loss (dB)**	**NEXT (dB)**	**FEXT (dB)**	**Return Loss (dB)**
200.0	0.28	48.0	37.1	18.0
250.0	0.32	46.0	35.1	16.0

4) Assembled Patch Cord

CATEGORY 6 – ASSEMBLED PATCH CORD				
Frequency (M Hz)	**2 m Cord NEXT (dB)**	**5 m Cord NEXT (dB)**	**10 m Cord NEXT (dB)**	**Return Loss (dB)**
1.0	65.0	65.0	65.0	19.8
4.0	65.0	65.0	65.0	21.6
8.0	65.0	65.0	64.8	22.5
10.0	65.0	64.5	62.9	22.8
16.0	62.0	60.5	59.0	23.4
20.0	60.1	59.6	57.2	23.7
25.0	58.1	56.8	55.4	24.0
31.3	56.2	54.9	53.6	23.0
62.5	50.4	49.2	48.1	20.0
100.0	46.4	45.3	44.4	18.0
125.0	44.5	43.5	42.7	17.0
150.0	43.0	42.1	41.4	16.2
175.0	41.8	40.9	40.2	15.6
200.0	40.6	39.8	39.3	15.0
225.0	39.7	38.9	38.4	14.5
250.0	38.8	38.1	37.6	14.0

2.2 CABLE REQUIREMENTS

A. General

1. The cables shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on TIA -568-C.2 equivalent cable rating.
2. Colors:

    a. Device outlets, patch panel termination labels, and patch cords may be colored to differentiate applications types. Horizontal voice/data cables do not require separate colors. Refer to Technology drawings (symbol legend) for additional requirements on color coding.

B. Category 6 Plenum Rated – Horizontal Cable

1. General:

a. This cable shall meet the minimum requirements noted in Performance and Criteria Section for Category 6.

2. Application: Primarily for communications horizontal cable installation within duct, conduits or cable trays. May also serve in the building backbone and riser applications.
3. Construction:

a. Insulation: Flame retardant semi-rigid Fluoropolymer.
b. Shield/Sheath: None.
c. Filling Compound: None.
d. Jacket: Flame retardant PVC.

C. Category 6 Outdoor Rated – Horizontal Cable

1. General:

a. This cable shall meet the minimum requirements noted in Performance and Criteria Section for Category 6.

2. Application: Primarily for communications horizontal cable installation within duct or conduits in outdoor or underground locations.
3. Construction:

a. Insulation: Polyethylene.
b. Shield/Sheath: None.
c. Filling Compound: Yes, water block filling compound.
d. Jacket: Polyethylene.

2.3 TERMINATION REQUIREMENTS

A. General

1. All terminations shall meet the minimum requirements noted in Performance and Criteria Section for each respective cable type based on TIA -568-C.2 equivalent cable rating.
2. All terminations for copper cables located on the face of the building or at remote locations outside of the building footprint (i.e. IP security cameras, WLAN data, etc.) shall have surge protectors at the termination point within the communications room. Contractor shall comply with manufacturer recommendations.
3. Specific and dedicated patch panels shall be used when multiple TIA-568-C.2 cable categories are used on the same project.
4. Provide all necessary wiring terminals and horizontal cable managers.

5. Provide double-sided horizontal cable manager above and below each patch panels as indicated in 271100.
6. Terminate 4-pairs per RJ45 jack per T568B standard termination. Exact requirements shall be coordinated and approved with Owner, Architect, and Engineer prior to initiating any work.
7. Specific communication device outlet types shall be grouped together on patch panels. Additionally, 20% spare jacks shall be added within each grouping.

B. RJ45-Type Patch Panels

1. Type: RJ45-Type.
2. Pin Configuration: T568B.
3. Mounting Configuration: 19-inch Rack.
4. Size: 48-port (provide as required to terminate all cable).
5. Colors:

    a. Patch panel termination labels may require color coding to differentiate applications types. Refer to Technology drawings (symbol legend) for additional requirements on color coding.

6. Cable Interface:

    a. Input: 110-Type (back).
    b. Output: RJ45-Type (front).

7. Electrical Specifications:

    a. TIA-568-C.2:
    b. Insulation Resistance: 500 MegaOhms (minimum).
    c. Current Rating: 1.5A @68 ^{O}F (20 ^{O}C).
    d. Dielectric Withstand Voltage: 1000 VAC RMS, 60Hz (minimum), contact-to-contact and 1,500 VAC RMS, 60Hz (minimum) to exposed conductive surface.
    e. UL and cUL Listed
    f. FCC Part 68.

8. Plug Requirements:

    a. Retention Force: 30-lb (133N).
    b. Insertion Life: 750 minimum.
    c. Plug/Jack Contact Force: 0.22-lb (100g).

9. Temperature

    a. Operating: +14 to +140 ^{O}F (-10 to +60 ^{O}C).
    b. Storage: -40 to +158 ^{O}F (-40 to +70 ^{O}C).

C. RJ45-Type Device Outlet Jacks

1. Type: RJ45-Type
2. Pin Configuration: T568B.
3. Mounting Configuration: Faceplates, Trim Plates, and Modular Patch Panels.
4. Colors:

    a. Jacks and/or termination labels may require color coding to differentiate applications types. Refer to Technology drawings (symbol legend) for additional requirements on color coding.

5. Cable Interface:

    a. Input: 110-Type (back).
    b. Output: RJ45-Type (front).

6. Electrical Specifications:

    a. TIA-568-C.2:
    b. Insulation Resistance: 500 MegaOhms (minimum).
    c. Current Rating: 1.5A @68 ^{O}F (20 ^{O}C).
    d. Dielectric Withstand Voltage: 1000 VAC RMS, 60Hz (minimum), contact-to-contact and 1,500 VAC RMS, 60Hz (minimum) to exposed conductive surface.
    e. UL and cUL Listed
    f. FCC Part 68.

7. Plug Requirements:

    a. Retention Force: 30-lb (133N).
    b. Insertion Life: 750 minimum.
    c. Plug/Jack Contact Force: 0.22-lb (100g).

8. Temperature

    a. Operating: +14 to +140 ^{O}F (-10 to +60 ^{O}C).
    b. Storage: -40 to +158 ^{O}F (-40 to +70 ^{O}C).

D. Faceplates:

1. General:

    a. Faceplates and/or trim plates shall be provided at each communication device location as necessary to install jacks.
    b. No communication device cable and outlet jack shall be installed without a faceplate to tightly secure assembly.

c. All unused ports shall have a blank dust cover installed. The color of each dust cover shall match the faceplate color as closely as possible, unless otherwise indicated.
d. Faceplate and/or surface box shall be provided at modular furniture locations. Coordinate requirements with Owner, Architect, and Engineer prior to purchasing components and initiating installation.
e. Wall telephone locations shall use a modular faceplate with standard integrated mounting knobs for installing telephone handset to wall.
f. Coordinate faceplate requirements at specialty locations for floor boxes, surface raceway, surface mount boxes, and other locations accordingly.

2. Material: (Refer to Technology Drawing details for additional information.)

   a. Wall Devices: Stainless Steel.

3. Type: RJ45 Standard Form Factor.

2.4 PATCH CORD REQUIREMENTS

A. General:

1. The patch cords shall meet the minimum requirements noted in Performance and Criteria Section for Category 5E, 6, and 6A as applicable based on TIA-568-C.2 equivalent cable rating.
2. Patch cords shall be provided as part of project at main cross-connects, intermediate cross-connects, horizontal cross-connects, and communication device outlet locations.
3. Exact patch cords requirements including TIA-568-C.2 category, quantity, and lengths shall be coordinated with Owner, Architect, and Engineer.
4. The sum of patch cord lengths when added the permanent basic link shall not exceed 325-feet (100m).
5. Construction: Unshielded Twisted Pair type.
6. Electrical Specifications:

   a. TIA-568-C.2:
   b. UL and cUL Listed CM Cordage
   c. FCC Part 68.

7. Plug Requirements:

   a. Retention Force: 30-lb (133N).
   b. Insertion Life: 750 minimum.
   c. Plug/Jack Contact Force: 0.22-lb (100g).

8. Temperature

    a. Operating: 14 to +140 ^{O}F (-10 to +60 ^{O}C).
    b. Storage: -4 to +140 ^{O}F (-20 to +60 ^{O}C).

9. Lengths: Refer to Technology drawings (symbol legend) for additional requirements on various patch cord lengths.
10. Colors:

    a. Patch cords shall be colored to differentiate applications types. Refer to Technology drawings (symbol legend) for additional requirements on color coding and quantities.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

B. Elevator Interface

1. Provide for Elevator Junction Box requirements, as follows:

    a. Low Voltage Cabling Contractor shall provide an elevator device junction box located within or outside of the Elevator Machine Room, for interface of elevator devices (elevator phones, IP security cameras, etc.) to be located within the elevator cab(s). This requirement complies with ANSI A17.1 code which prevents work within the Elevator Machine Room, other than specific elevator work.
    b. Elevator device J-box shall include a keyed lockable door. Additionally, J-box shall have proper terminal strips suitable for terminating all cables within the J-box.
    c. Coordinate exact location of elevator device junction box with the Elevator Contractor, Architect, and Engineer, prior to installation.
    d. Provide all cabling as required between the elevator device J-box and the IC-room for all elevator device interfaces.
    e. Provide all required interface points for connecting to elevator relays and travel cables.
    f. The Elevator Contractor shall provide all cables in conduit from the elevator machine room to the associated elevator device J-box.
    g. Cables entering the elevator device J-box shall be appropriately labeled by the Elevator Contractor, so that the Low Voltage Cabling Contractor can connect to the appropriate wires. Wires should be individually labeled to separate them from other elevator functions and to assist the Low Voltage Cabling Contractor in making proper connection points.

C. Labeling:

1. The labeling scheme shall be provided by the Contractor and coordinated with Owner, Architect, and Engineer prior to finalizing and initiating any work. A sample scheme shall be submitted for approval.
2. Each cable, wiring block, patch panel, and termination shall be identified at the main cross-connect (MC), at the intermediate cross-connect (IC), and at each station termination.
3. Refer to Specification Section 27 05 00 for additional requirements that shall be fulfilled as part of this specification section.

D. Horizontal Systems Cable Testing:

1. All communications copper horizontal cabling and pairs shall be tested for electrical continuity and wire map.
2. Cable testing shall confirm to the cables TIA-568-C.2 rating.
3. All cabling will be test/certified for conformance to the TIA-568-C.2 Category Category 5E, Category 6, and Category 6A specifications using TSB-67 Level 4 time domain reflectometer (TDR) or approved equivalent test equipment.
4. Cable tests will be per industry standard and also include the following:

    a. Cable Length
    b. Attenuation
    c. NEXT
    d. Characteristic Impedance
    e. Mutual Capacitance
    f. Resistance
    g. Noise
    h. Wire Map

5. (5) Printed test results shall be submitted on disc and printed copies by the Contractor for approval by Owner, Architect, and Engineer.

END OF SECTION 27 15 00

APPENDIX 1 - EQUIPMENT SCHEDULE

General Notes:

1. This specification is intended to be performance based, with the expectation that an "end-to-end" solution is provided by one of the "pre-approved" manufacturers (or partnerships) listed below.
2. Products listed below are intended to establish "benchmark" products from one or more of the "pre-approved manufacturers". The listed benchmark products shall be used as a baseline when submitting products from a pre-approved manufacturer that does not have specific products listed.
3. Pre-approved manufacturers (listed in alphabetical order) include:
   a. CommScope (Systimax)
   b. Corning
   c. Berk-Tek / Leviton
   d. Belden
   e. General / Panduit
   f. Superior Essex / Ortronics

Table 1 - Horizontal Cable / Connectivity Products

Item	Part Name/Description	Manufacturer	Part Number
1	Category 6 Plenum Rated Cable	CommScope Systimax	2071E
		Superior Essex	77-###-yB
		Belden	2413
2	Category 6 OSP Rated Cable, Gel-filled	CommScope Systimax	1572A
		Superior Essex	04-001-68
		Belden	OSP6U
3	Category 6 Indoor/Outdoor Cable	CommScope	CS34P-IO
		Superior Essex	04-001-63
		Belden	2143A
4	Category 6 Information Outlet (XX = Color)	CommScope Systimax	MGS400-XX
		Leviton	61110-RX6
		Belden	AX101321

Table 1 - Horizontal Cable / Connectivity Products			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
5	24-port Patch Panel - Modular (Individual Jack Inserts)	CommScope Systimax	360-E-MOD-1U-24
		Leviton	49255-H24 - 1U
		Belden	AX103114
6	48-port Patch Panel - Modular (Individual Jack Inserts)	CommScope Systimax	360-E-MOD-2U-48
		Leviton	49255-H48 - 2U
		Belden	AX103115

Table 2 - Miscellaneous Connectivity Products			
Item	**Part Name/Description**	**Manufacturer**	**Part Number**
1	Surface Mount Box "Biscuit" (# = Number of Ports, XX = Color)	CommScope	M10#SMB-B-XX
		Leviton	41089-#XP
		Belden	AX105353
2	Blank Outlet Dust Covers (XX = Color)	CommScope	M20AP-XX
		Leviton	41084-0BX
		Belden	AX102262
3	Stainless Steel Faceplates (with label window) (# = Number of Ports)	CommScope	M1#SP-L
		Leviton	43080-1L#
		Belden	AX104231
4	Plastic Faceplates (with label window) (# = Number of Ports, XX = Color)	CommScope	M1#L-XX
		Leviton	42080-#XS
		Belden	AX102655

APPENDIX 2 - SPECIFICATION COMPLIANCE MATRIX TEMPLATE

Indicate compliance of the proposed equipment and/or services by the word "Comply" following each paragraph number. Indicate an exception to the requirement by the word "Exception" following the applicable paragraph number. Should the proposed equipment and/or services not entirely comply with the requirements specified, but ultimately achieve the intent, the Bidder shall explain fully the extent, or lack thereof, of compliance for the applicable equipment and/or services proposed. Instances where there is no indication of compliance or exception shall be considered non-compliant.

Contractor shall submit Compliance Matrix with the Bid Proposal AND at the time of Product Data submittal (as indicated previously in this specification) so that a complete system submittal reviewed can be performed. Contractor shall use the following template to create a full Compliance Matrix for each specification section.

	COMPLIANCE	**EXPLANATION**
PART 1		
1.1		
A	COMPLY	
B	EXCEPTION	Note clarifications and/or reason for exception here.
C	COMPLY	
1.2		
A.1	COMPLY	
A.2	COMPLY	
B	COMPLY	
C.1	COMPLY	
C.2	COMPLY	
D.1a	COMPLY	
D.1b	COMPLY	
D.2a	COMPLY	
xx	COMPLY	
xx	COMPLY	

SECTION 27 33 53 - TECHNOLOGY UNINTERRUPTABLE POWER SUPPLY (UPS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Product Appendix: Refer to Appendix 1, Equipment Schedules, for specific product information on the benchmark products. These equipment schedules should be the baseline for product data submittals, but are not intended to be an all-encompassing bill of materials.

B. Refer to Section 27 05 00 (Part 1 and Part 3) for requirements that shall be fulfilled as part of this specification section.

C. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections.

D. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply.

E. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

F. Rough carpentry is specified in a Division 6 section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products and solution by one of the following UPS Manufacturer:

1. American Power Conversion Corp. (APC by Schneider Electric)
2. Libert (Emerson Electric Co.)
3. Approved Equal

2.2 UPS MANAGEMENT AND MONITORING SYSTEM

A. General:

1. The system shall be installed with Management and Monitoring System.
2. System shall provide for interactive interfaces to all UPS equipment. The UPS equipment shall be interfaced to the facility converged data network.
3. System shall allow for real-time remote management and monitoring of UPS equipment from an Operator’s computer workstation.

4. The system shall have a customizable graphical user interface (GUI) for visual display and indication of system status. The GUI shall include the following minimum criteria.

    a. Facility maps with interactive equipment icons of major system components and antennae locations.
    b. Interactive equipment icons should be color coded to indicate current status and be clickable by mouse to show device information, status, log, configuration, etc.

5. System configuration shall include at a minimum coordination and assistance for one system integration either via SMTP or XML to other Owners preferred monitoring tools.

B. System Features:

1. Remote Equipment Configuration and Troubleshooting
2. Graphical User Interface (GUI)

    a. Color coded icons for quick visual reference.
    b. Equipment Status (threshold, status, alarm, etc.)

3. Alarm Notification

    a. UPS Status (Off-Line, On-Line, On-Battery, etc.)
    b. Emergency Power Off
    c. Equipment Load
    d. Overload
    e. Battery Status
    f. Low Battery
    g. Replace Battery
    h. Bypass Indicators.

4. Web Based Access

    a. VPN credentials and User Login
    b. Remote Diagnostics
    c.

5. Maintenance Schedule, Alerts, Reminders, Notification, and Logs
6. System Administration

    a. Administrator Login, Passwords, and Security Access Level
    b. Users Login, Passwords, and Security Access Level

C. System Requirements:

1. Operating System: For use on Windows 10
2. Equipment Networking: Ethernet 10/100/1000 Mbps (RJ45 Jack).

D. Product Specification:

1. APC – Symmetra PX 40kW scalable – SY40K40F
2. Libert – EXM 40kVA - 47SA040EAC525XW
3. Or approved equal.

2.3 RACK MOUNT TYPE - UPS EQUIPMENT

A. General Requirements:

1. Rack mounted UPS equipment shall be provided in technology and communications equipment and distribution rooms to support sensitive electronic equipment including but not limited to data network switches, telephone system equipment, security video recording servers, UPS, public safety head-end equipment, building operations radio head-end, etc.
2. UPS equipment shall be provided in rack mount type as necessary and appropriate to application. Contractor shall verify mounting application and load requirements for each scenario.
3. UPS equipment shall be modular allowing easy replacement of power modules, batteries, etc.
4. UPS equipment shall be provided for supporting interim power of critical and sensitive technology during automatic-transfer from loss of standard building power to emergency generator power.
5. UPS equipment shall be provided for an organized shutdown of critical and sensitive electronic equipment in event of catastrophic power loss.
6. All UPS equipment shall have a real time Management and Monitoring System for remote system monitoring, administration, and notification. Remote system monitoring shall include access from local computer workstations located within facility and/or Owner's premise as well as web based access from users located remotely at home, vacation, etc.
7. Refer to schedule attached to the end of this specification for UPS types and locations.

2.4 ALTERNATES

A. Contractor Proposed Alternates

1. The Contractor shall include pricing to standardize on a single UPS type for the communications rooms. This shall be based on the largest UPS size of 6KVA.
2. The Contractor may propose alternates for Owner consideration.
3. All alternates shall include pricing, description, equipment cut-sheet and any other technical document necessary. Additionally, the description shall include reason for proposed change and difference from specified product and/or performance requirements.

B. Manufacturer Proposed Alternate

1. The UPS Manufacturer may propose alternates for Owner consideration.
2. All alternates shall include pricing, description, equipment cut-sheet and any other technical document necessary. Additionally, the description shall include reason for proposed change and difference from specified product and/or performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where equipment is to be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Provide detailed site survey to determine best implementation and installation of equipment.

3.2 INSTALLATION

A. General:

1. This Section describes the installation locations for the products and materials, as well as methods associated with the UPS system. These Specifications, along with the drawings shall be followed during the course of the installation.
2. Examine areas and conditions under which equipment are to be installed. Notify Owner, Architect, and Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.
3. The Contractor shall be knowledgeable of work to be performed by other trades and take necessary steps to integrate and coordinate their work with other trades.
4. The Contractor shall be responsible for furnishing all materials as specified herein and as indicated on the drawings and any other component required for a complete system.
5. The Contractor shall verify space requirements and locations before ordering, shipping, and starting installations. Inappropriate conditions shall be immediately reported to Construction Manager, Owner, Architect, and Engineer prior to initiating installation.
6. All equipment shall be installed for optimal performance.
7. All equipment shall be installed to allow for easy adds, moves, and other changes in the future.
8. Construction within communication rooms or any room where equipment is to be installed must be substantially complete before the installation of equipment. This includes, but is not limited to, the installation of plywood backboard, cable tray or ladder rack, electrical outlets, light fixtures, sprinklers and ductwork. All walls shall also be painted before the installation.

9. All equipment and components noted in this section and drawings or anything else required shall be provided and completely setup and installed. This includes but not limited to UPS chassis, power modules, batteries, installation into equipment racks, input power connections (hardwire or receptacles), output receptacle connections to rack power strips or PDUs, monitoring and control system, equipment configuration and set points, data network connections, etc.
10. The Contractor is required to coordinate their efforts with the other trades and sub-contractor who may be working within the same vicinity to avoid conflict and lost time.
11. The Contractor shall supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.
12. The contractor shall not install any component in a manner or condition that will void manufacturer and/or contractor warranty. Any such conditions that prevent an acceptable install shall be immediately reported to Construction Manager or General Contractor, Owner, Architect, and Engineer prior to initiating installation. All mis-installed components will be removed and replaced with new at the Contractors expense. No additional cost will be submitted to Owner.
13. All equipment shall be installed in a neat and workmanlike manner, arranged for convenient operation, testing and future maintenance.

B. Equipment Installation:

1. Install surge suppressors where ac-power-operated devices are not protected against voltage transients by integral surge suppressors specified in UL1449. Install surge suppressors at the devices' power-line terminals. Comply with Division 26 Section "Transient Voltage Suppression."
2. Mount chassis equipment in equipment racks and cabinets provided by base project (unless noted otherwise) as recommended by manufacturer. Group related items in methodical sequence.
3. Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space.
4. Install all power modules, batteries, transformer modules, etc. into UPS chassis.
5. Interface and connect UPS system equipment as required to power (receptacles or hardwire), power strips and PDUs, and data network.
6. All equipment, interfaces and connections shall be labeled.

C. System Management and Monitoring Software Installation:

1. Install software on Owner provided computers.
2. Coordinate computer and data network requirements with Owner’s IT Group. This should include MAC and IP addressing, VLAN assignment, bandwidth requirements, class of service (CoS), VPN requirements, etc.
3. The system management and monitoring software shall be fully setup, programmed, and configured including but not limited to the following:

    a. Date and Time.
    b. Networked equipment end points.

c. Web portals, user access, and VPN.
d. Administrator accounts, passwords, and security levels.
e. User accounts, passwords, and security levels.
f. Device thresholds, status, alarm points, alerts, and notification.
g. Remote diagnostics.
h. System Inventory.
i. Event reporting protocol.
j. System logs including status, performance, alarms, history, and others.
k. Maintenance log, schedules, and notification.

3.3 COORDINATION

A. Design Coordination: All components proposed by the Contractor shall be coordinated with the Owner and Architect. Provided below is a general list of major items that shall be documented in a table and coordinated. The list provided below is to be used as an example and not intended to be all inclusive or limit items required to be reviewed and coordinated.

1. Equipment Type and Physical Size.
2. Equipment Clearances Requirements.
3. Rack Units required per location.
4. Electrical Power (voltage, amp, loads, receptacle types, and hardwire connections)
5. HVAC (heat dissipation and equipment operating temperature range)

B. Installation Coordination: The Contractor shall field coordinate all work with Construction Manager and other Sub-Contractors and Trades as necessary to minimize conflicts.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Contractor shall engage a factory-authorized service representative to inspect field-assembled components and equipment installation, and supervise pre-testing, testing, and adjusting of equipment.

B. Inspection: Contractor shall verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

C. Pre-testing: Contractor shall align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Replace malfunctioning or damaged items. Retest until satisfactory performance and conditions are achieved.

D. Operational Tests: Contractor shall perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Equipment/Component Fail Tests:

1. Contractor and Manufacturer shall perform fail tests of key components and features of each UPS to ensure operation in various critical event conditions.
2. Fail test shall only be completed once entire system has been installed with all pre-testing and operational testing completed.
3. Fail tests shall be performed by Contractor and Manufacturer on each UPS installed.
4. Additionally, Owner, Architect, and Engineer will schedule random fail tests prior to system acceptance and after all testing has been completed and results posted.
5. Each test shall be logged including UPS ID No., test performed, all components online/offline, outcome, and resultant noted as normal or fail.
6. All mis-installed equipment and/or improper operating components shall be replaced and re-tested as necessary to ensure all equipment is operating normally and as specified.
7. Provided below are the fail test required. Contractor and Manufacturer shall add any additional tests they feel are required.

    a. Emergency Power Off.
    b. Trip Electrical Panel Board Circuit Breaker.
    c. Disconnect Input Power Cord.
    d. Physically remove Power Modules (individually and all).
    e. Physically remove Batteries (individually and all).

F. Test Schedule: Contractor shall schedule tests after Operational testing has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days notice of test schedule.

G. Test Results: Contractor shall record test results and publish in electronic and hard copies for distribution to Owner.

H. Re-Test: Contractor shall correct all deficiencies identified by tests and observations, and re-test until specified requirements are met.

3.5 CLEANING

A. Contractor shall clean installed items using methods and materials recommended by manufacturer.

B. Contractor shall clean system components.

3.6 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment.

1. Train Owner's maintenance personnel on procedures and schedules for system administration, routine use, troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data" or Division 26 Section “General Electrical Requirements.”
4. Schedule training with Owner, through Architect/Engineer, with at least seven days advance notice.
5. Conduct a minimum of 10 hours' training as specified in instructions to Owner's employees in Division 1 Section "Contract Closeout" or Division 26 Section “General Electrical Requirements.” This shall include training with System Maintenance and Monitoring Software System.

END OF SECTION 27 33 53

SECTION 28 46 00 - ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26, Basic Electrical Materials and Methods applies to work specified in this section.

C. Division 26 “Electrical Identification” applies to work in this section for labeling of conduit and equipment.

D. Division 28 “Smoke Management” applies to work specified in this section.

E. Related work specified in other divisions of these specifications.

1. Installation of duct type smoke detectors. Control wiring from Fire Alarm Control equipment to mechanical fans, dampers, control equipment both low voltage and line voltage and all other control wiring associated with mechanical equipment.

1.2 SUMMARY

A. Provide a complete and coordinated Class B wiring, fire alarm system in accordance with the contract documents. Audible intelligibility shall be provided throughout the scope impacted by the building. Provide expansion NAC panel within the Vendor room to feed the additional devices for this scope and allowing for future device additions in the area.

B. Contractor to include any and all hardware expansions and firmware updates to the existing Fire alarm system to include the renovated space.

C. Contractor require to relist the Fire Alarm system as required to Steamboat Springs Fire Department.

D. Any fire alarm devices, wiring etc., not indicated on the drawings, but required by the local Building Department and Fire Department, shall be provided as part of this specification. Contractor shall adjust locations and quantities of fire alarm devices as required to comply with local codes. As minimum, an additional 3 audio/visual alarms 2 smoke detectors and 2 addressable interface devices shall be included in price including labor.

E. Refer to Life Safety Report for sequence of events/connection indicated on drawings.

F. Contractor shall assume all responsibilities for obtaining a fire alarm permit.

1. Contractor / Fire Alarm Installer shall develop a submittal including plan drawings, calculations, etc. to submit to the local jurisdictional authority in order to obtain a permit.
2. Contractor / Fire Alarm Installer shall provide and apply a seal / signature to fire alarm drawings as required by the authority having jurisdiction in order to obtain a permit.

1.3 SUBMITTALS

A. Procedure - prepare and make submittals listed in accordance with Division 1, “Submittals” as required by Local Department of Fire.

B. Product Data - submit product data similar/compatible to the existing manufacturer within the Gondola Square Building. Specifications, recommendations, and installation instruction for use intended. The data shall include but is not limited to the following:

1. Cabinets
2. Manual stations
3. Batteries
4. Battery charger
5. Smoke sensors
6. Visual alarms
7. Audio/visual alarms
8. Addressable interface devices
9. Wiring conductors
10. Wire connectors
11. Manufacturer’s recommended calibrated test method for smoke sensors and smoke detectors.
12. Include Underwriters Laboratories or Factory Mutual listing cards for equipment provided.

C. Drawings

1. Detailed drawings for the fire alarm system shall consist of illustrations, schedules, performance charts, battery calculations, point lists, instructions, diagrams, and complete detailed drawings of the fire alarm system.
2. A descriptive index of drawings in the submittal with drawings listed in sequence by drawing number.
3. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
4. Floor plans drawn to a scale not less than 1/8 inch equals 1 foot which clearly show locations of devices, equipment, risers, panels, electrical power connections, approximate location of conduit runs, and other details required to clearly describe the proposed system.
5. A 1/4” scale plan view of the fire command center and security office with dimensioned layout of all equipment therein.

6. Location of control panels, detectors, supervisory switches, manual pull stations, visual/audible alarms and electrical devices. Clearly and completely indicate the function of the control panel and devices. Indicate conduit routing and sizes, and the number of conductors contained in each. Indicate points of connection and terminals used for electrical field connections in the system, with a wiring color code. Indicate termination points of devices and indicate the interconnection of modules required for proper operation of the system. Indicate interconnection between modules and devices. Control diagrams shall be supplemented with a narrative description of the system. Point-to-point wiring diagrams shall indicate control panel wiring and make and model of devices and equipment. Signal circuit diagrams shall show current draw and load by device and by circuit.

D. Design Data

1. Battery standby power requirements calculations.
2. Submit design calculations for the system substantiating battery standby power requirements, calculations showing battery capacity and supervisory and alarm power requirements.

E. Field Test Reports

1. Preliminary and acceptance tests.
2. Include the control panel and initiating and indicating devices, a unique identifier for each device with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information.

F. Record Drawings

1. Upon completion, and before final acceptance of the work, submit a complete set of CADD generated as-built drawings for the fire alarm system, including components and any other associated appurtenances. Include as-built circuit diagrams complete with conductor color codes and a listing of initiating device locations and fixing voltage for each. Submit an electronic set of all documentation. Submit as-built drawings in addition to the record drawings required by Division 1, “Operation and Maintenance Data”.
2. List of FACP alphanumeric address names
3. Request for formal inspection and tests
4. When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests.

G. Operation and Maintenance Manuals

1. Smoke and thermal sensors
2. Interface and control modules
3. Submit in accordance with Division 1, “Operation and Maintenance Data”. Include current unit prices and source of supply for parts list, and a list of parts recommended by the manufacturer to be replaced after one year and three years of service. Include in the

fire alarm control panel, full and comprehensive manufacturer's repair and service manuals.

1.4 QUALITY ASSURANCE

A. Qualifications the manufacturer's authorized distributor must substantiate that within a 50-mile radius of the job site, there is an established agency which stocks a full complement of parts and offers full service during normal working hours on all equipment to be furnished and that the agency will supply parts without delay and at a reasonable cost.

B. Qualifications of Installer: Prior to installation, submit data for approval showing that the Contractor has successfully installed addressable, analog intelligent interior fire alarm systems of the same type as specified herein, or that the Contractor has a firm contractual agreement with a subcontractor having such required experience. Include the names and locations of at least two installations where the Contractor or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months. Submit names and phone numbers of points of contact at each site.

C. Codes and Standards: Except as modified by governing codes and where more stringent standards are specified by the contract documents, comply with the latest applicable provisions and the latest recommendations of the following:

1. National Fire Protection Association (NFPA): NFPA 70, "2017 National Electrical Code": NFPA 72, "National Fire Alarm and Signaling Code": NFPA 241, "Standard for Safeguarding Construction, Alteration and Demolition Operations": NFPA 101, "Life Safety Code".
2. Factory Mutual (FM): FM 37825, "1952 Approved Guide".
3. Underwriters Laboratories (UL): UL FPED, "Fire Protection Equipment Directory; UL 268, "Smoke Detectors for Fire Protective Signaling Systems;" UL 164, "Control Units for Fire Protective Signaling Systems, UL 197/ANSI, "Codes applicable to Americans with Disabilities Act Compliance", "Testing for Fire Resistive Cables" UL 2196, "Cables for Power-Limited Fire-Alarm Circuits" UL 1424.
4. Americans with Disabilities Act
5. Local and City Codes and Amendments.
6. International Building Code, IBC-2015.
7. International Fire Code, IFC-2015.

D. Federal Specifications Compliance: Comply with FED-STD-595, "Colors used in Government Procurement".

E. Guarantee - all components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of 12 months upon acceptance. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within 50 miles from the job site.

F. Testing - conduct a total system test for Architect/Engineer and Local Fire Department. Tests shall include as a minimum.

1. Verify operation of all manual pull stations and detectors.
2. Verify line supervision of each initiating and indicating circuit.
3. Verify the Class B operation of each initiating circuit.
4. Verify operation of all indicating devices.
5. Verify operation of all alarm initiated function.
6. Perform smoke test(s) as directed by the Local Fire Department. Provide electricians, and factory representatives to perform as many tests as required to approve smoke management system. The Engineer, Owner and Architect shall be advised a minimum of five working days before each test.

G. All equipment provided as part of this section shall be the product of a single fire alarm equipment manufacturer.

H. Equipment and devices shall be from a manufacturer who has been manufacturing similar products for a minimum of 5 years. Furnish materials and equipment that are current products of one manufacturer regularly engaged in the production of such equipment.

I. Regulatory Requirements

1. Devices and equipment for fire alarm service shall be listed by Underwriters Laboratories, Inc. and listed in UL FPKD or approved by Factory Mutual and listed in FM P7825. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.

J. Requirements for Fire Protection Service

1. Equipment and material shall have been tested by Underwriters Laboratories, Inc. and listed in UL FPKD or approved by Factory Mutual and listed in FM P7825. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.

K. Standard Products

1. Materials and equipment shall be standard new products of a manufacturer regularly engaged in the manufacturer of such products. Select material from one manufacturer, and not a combination of manufacturers, for any particular classification of materials.

L. Modification of References

1. In NFPA publications referred to herein, consider advisory provisions to be mandatory, as though the word “shall” had been substituted for “should” wherever it appears; interpret reference to “Authority Having Jurisdiction”.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, and other contaminants.

1.6 SPARE PARTS

A. Spare parts shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, stamping or tagging. Furnish the following:

1. Three (bases and heads) of each type smoke (area and duct) and thermal sensors.
2. Three of each type monitor module.
3. One of each type audio/visual device.
4. One of each type visual device.

PART 2 - PRODUCTS

2.1 SYSTEM DESIGN

A. Acceptable Manufacturers: Refer to Section 26 05 03.

B. Scope

1. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performing all operations in connection with the installation of the multiplex addressable Fire Alarm System (Class A) as shown on the drawings, as hereinafter specified, and as directed by the architect/engineer.
2. The Fire Alarm System shall consist of all necessary hardware and software equipment to perform the following functions:

    a. Fire Alarm and Detection Operations.
    b. One-way Supervised Automatic Voice Alarm Operations.

3. Each item of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. The Control Equipment for all Systems shall be listed under UL category UOJZ as a Single Control Unit.
4. The complete installation shall conform to the applicable sections of NFPA-72, NEC 760, Life Safety Code 101, and Local Authorities Having Jurisdiction.
5. Nodes as defined for this specification shall be intelligent, microprocessor based devices that connect to, and handle network communications.

6. By programmable selection at each node:

    a. The specific detail information of any point connected to any node in the network may be made accessible (declared public) to the network.
    b. Points within each node shall be able to be grouped by area, type of device, type of function, or any other user selectable category, and custom labeled as a point list. A point list shall be acted upon as though it was a point for purposes of interaction with the node custom control program. Detail information shall not burden the point list messages, only the quantity and type of status shall be broadcast into the network.

C. Alarm System

1. Existing system installed.

D. Job Site Changes

1. To accommodate and facilitate job site changes, initiating and indicating circuits shall be individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, a non-latching circuit or an alarm verification circuit.

E. Operations

1. Sequence of Operation (Existing)
2. Abnormal Conditions (Existing to remain - include integration of new devices and new Fire Protection system)
3. Alarm or Trouble Condition(Existing to remain - include integration of new devices and new Fire Protection system)
4. History Logging (Existing to remain - include integration of new devices and new Fire Protection system)
5. Detection Operation (Smoke Sensors) (Existing to remain - include integration of new devices and new Fire Protection system)

    a. Smoke sensors shall be smoke density measuring devices having no self-contained alarm set point (fixed threshold.) The alarm decision for each sensor shall be determined by the fire alarm control panel. The control panel shall determine the condition of each sensor by comparing the sensor value to the stored values.
    b. Control panel shall maintain a moving average of the sensors' smoke chamber value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. System shall automatically maintain a constant smoke obscuration sensitivity for each sensor (via the floating threshold) by compensating for environmental factors. Smoke obscuration sensitivity shall be adjustable at least twice a day and within UL 26B window (0.5 percent to 4.0 percent) to compensate for any environment.
    c. System shall automatically indicate when an individual sensor needs cleaning. When a sensor's percentage of compensation reaches a predetermined value, a

"DIRTY SENSOR" trouble condition or similar display shall be audibly and visually indicated at the control panel for the individual sensor. Additionally, the LED on the sensor base shall glow steady giving a visible indication at the sensor location. To prevent false alarms, these "DIRTY" conditions shall in no way decrease the amount of smoke obscuration necessary for system activation.

d. Control panel shall perform an automatic self-test routine on each sensor which will functionally check sensor sensitivity electronics and ensure the accuracy of the values being transmitted to the control panel. Sensors that fail this test shall indicate a trouble condition with the sensor location at the control panel.

e. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device:

    1) Primary status
    2) Device type
    3) Present average value
    4) Present sensitivity selected
    5) Sensor range (normal, dirty, etc.)

f. An operator at the control panel, having a proper access level, shall have the capability to manually control the following for each sensor:

    1) Alarm detection sensitivity values.
    2) Enable or disable the point.
    3) Control a sensor's relay driver output.

g. It shall be possible to program the control panel to automatically change the sensitivity settings of each sensor based on time-of-day and day-of-week (for example, to be more sensitive during unoccupied times and less sensitive during occupied periods.)

h. Control panel shall have the capability of being programmed for a pre-alarm or two-stage function. This function allows an indication to occur when, for example, a 3 percent sensor reaches a threshold of 2.5 percent smoke obscuration.

i. For increased smoke detection assurance, individually addressed smoke sensors shall be provided with field adjustable alarm verification. Only a verified alarm shall initiate the alarm sequence operation. System shall be initially set up with a 30-second verification period.

F. Primary Power (Existing to remain - include integration of new devices and new Fire Protection system)

G. Auxiliary Power (Secondary Power) (Existing to remain - include integration of new devices and new Fire Protection system)

H. Wiring

1. Conductors

a. Provide in accordance with NFPA 70 and NFPA 72. Conductors shall be copper. Conductors for 120/208-Volt circuits shall be No. 12 AWG minimum; single conductors for low-voltage D.C. circuits shall be a minimum No. 18 AWG twisted, shielded with drain wire minimum. Conductors shall be color-coded. Provide wiring in electrical metallic tubing conduit in dry locations not enclosed in concrete or where not subject to mechanical damage. Conceal conduit in finished areas. Identify conductors within each enclosure where a tap, splice, or termination is made. Identify conductors by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Wire the alarm initiating and notification signal devices so that removal will cause the system trouble device to sound. Each conductor used for the same specific function shall be distinctively color-coded. Use two different color codes for each interior alarm circuit; one for each loop. Each circuit color code wire shall remain uniform throughout circuit. Plenum rated cable can be used where approved by engineer and is concealed but accessible.

2. Terminations

a. Connections, junctions and conductor terminations shall be made with screw terminals at risers only. Terminate strips everywhere except in control panels. Terminations with operating voltage of 50-Volts or more shall be provided with protective cover and shall be labeled with the voltage.

2.2 COMPONENT DESIGN

A. Colors

1. Provide finish colors under this section in accordance with FED-STD-595.

B. Fire Alarm Control Panel (FACP) (Existing to remain - include integration of new devices and new Fire Protection system)

1. Supervision (Existing)
2. Reporting a Failure (Existing)
3. Devices (Existing)

a. FACP shall report by specific device and address, any device which has been removed from an addressable initiating circuit, and shall not disrupt the operation of the remaining devices to function. The system shall be capable of sounding a Trouble if the device replaced is a different device type than the device removed.

4. Accessories (Existing)
5. Power (Existing)

6. Hardware and Software (Existing)
7. Smoke Sensors (Existing)

C. Manual Stations (to match existing)

1. Provide an addressable noncoded double action type with mechanical reset features. Locate stations as indicated. Stations shall be die cast aluminum semi-flush or surface-mounted. Surface-mounted boxes shall be painted the same color as alarm station. Mount stations with the base at 4 feet above finished floor and no more than 5 feet from any door, measured horizontally, as shown. Provide each station with screw-type terminals of proper number and type to perform functions required. Break-glass-front stations will not be permitted; however, a pull-lever, break-glass-rod type is acceptable. The manual alarm station shall require a key to reset or test.

D. Smoke Sensors (to match existing)

1. Provide analog addressable smoke sensors of the photoelectric type which shall communicate actual smoke chamber values to the system fire alarm control panel. Detectors shall be uniquely identifiable to FACP.
2. Sensors shall be listed to UL 268 and shall be documented compatible with the control equipment to which they are connected. Sensors shall be listed for both ceiling and wall-mount applications.
3. Each sensor base shall contain a LED that, when the control panel determines that a sensor is in the alarm or trouble condition, the control panel shall command the LED on that sensor's base to turn on steady, indicating the abnormal condition.
4. Sensor's electronics shall be immune from false alarms caused by electromagnetic interference and radio frequency interference.
5. All sensor addressing information shall be stored in the fixed base. Addressing information that is stored in the removable sensor is not acceptable.

E. Duct Smoke Detectors (to match existing)

1. Detectors in duct shall be analog addressable photoelectric type and listed by UL or FM for duct installation. Duct detectors shall be provided with approved duct housing, mounted exterior to the duct, and shall be provided with perforated sampling tubes extending across the width of the duct. Activation of duct detectors shall cause actuation of the fire alarm control panel in the same manner as other alarm initiating devices and in addition, cause all air handling units to be deactivated. Detector head shall contain amplifier switching circuitry. The amplifier switching circuit shall be entirely solid-state and operate with a nominal detector line voltage of 24-Volts D.C. Detectors to be equipped with screw terminals. Detector to be provided with indicating lamp and test switch and in test position bypass fan shutdown feature.

F. Addressable Point Identification Device (to match existing)

1. The Point Identification Device shall be provided to connect single supervised conventional initiating contact type device such as water flow switches, tamper switches,

single detectors, and other such devices to any of the two-wire intelligent analog loop cards. The Point Identification Device shall mount in a 4-inch square, 2 1/8-inch-deep electrical box and shall be capable of (Class "B") supervised wiring to the initiating device. The Point Identification Device shall contain an integral LED that annunciates module activation. The Point Identification Device shall provide address setting means switches and store an internal identifying code which the control panel shall use to identify the type of device.

G. Addressable Control Element

1. The Addressable Control Element shall be provided to connect and supervise, conventional indicating device or zone of indicating devices that required an external power supply, such as horns, strobes to any of the (2) wire intelligent analog loop cards. The Control Element shall be capable of operating as a relay (dry contact form C,) to control door holders, and other such devices. Control Elements shall mount in a 4 11/16-inch-square, 3-inch-deep electrical box and shall be capable of (Class "A") supervised wiring to the indicating or control device. Control Element shall contain an integral LED that annunciates module activation. Control Element shall provide address setting means switches and store an internal identifying code which control panel shall use to identify the type of device. The addressable Control element shall be capable of providing feedback to the FACP for positive confirmation of the controlled devices activity.

H. Audio/Visual Alarms (to match existing)

1. Provide recessed and surface-mounted approved combination audio/visual alarm devices consisting of an electronic horn for use in an electrically-supervised circuit and a top-mounted integral flashing strobe light. The alarm horn shall have a sound rating of at least 96 decibels at 10 feet. Provide lamps of the flashing stroboscopic type, powered from the control panel alarm circuit. Lamps shall produce a minimum of 75 candela and be designed for A.D.A. compliance. Lamps shall be protected by a polycarbonate lens and shall be labeled FIRE, and are to be mounted at 80 inches above the floor, unless noted otherwise on the drawings.
2. Visual alarms shall operate in unison with audio alarm system.

I. Visual Alarms (to match existing)

1. Provide flush and surface-mounted lamp assembly suitable for use in an electrically-supervised circuit. Provide lamps of the flashing stroboscopic type, powered from the control panel alarm circuit. Lamps shall produce a minimum of 75 candela and be designed for A.D.A. compliance. Lamps shall be protected by a polycarbonate lens and shall be labeled FIRE, and are to be mounted at 80 inches above the floor, unless noted otherwise on the drawings.
2. Visual alarms shall operate in unison with voice alarm system.

J. Outdoor Fire Light and Horn

1. Outdoor fire lights and horn suitable for wet locations complete with high intensity flashing light and alarm horn as integral unit.
2. The electrical light source shall be sealed in silicone and protected by a Lexan lens. The word “fire” shall appear on the lens.
3. The minimum sound level shall be 95 dB at ten (10) feet.

K. Remote Indicator Lights

1. Remote indicator lights shall be lighted red when the associated device is in alarm. Light shall be mounted in a stainless-steel coverplate with the appropriate legend engraved thereon. Indicators shall be a highly visible red LED.

L. Wiring

1. Provide Wiring materials under this section as specified in division 26, “Wires and Cables”, with the addition and modifications specified herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The work includes providing a new fully field programmable/addressable analog interior fire alarm and smoke detection system including associated equipment and appurtenances. Provide each system complete and ready for operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in strict accordance with the required and advisory provisions of NFPA 70, NFPA 72 and NFPA 241, except as modified herein.

B. Provide intelligent, analog addressable type manual pull stations, smoke sensors, thermal sensors, and audio/visual devices, including a stand-alone fire alarm control panel as located on the drawings and required by the fire department.

C. Pre-inspection - examine areas and conditions under which work of this section is to be performed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION CRITERIA

A. All fire alarm wiring shall be in conduit. All alarm and signal wiring shall be in accordance with the manufacturer’s recommendations and installed in an approved raceway specified in Section 26 05 33.

B. The contractors shall fully coordinate with all other trades for the proper wiring and control of all systems.

C. Control panel, annunciators, standby power module must be mounted with sufficient clearance for observation and testing. Final arrangement and location must be approved by the Architect/Engineer and Fire Department

D. Flexible connectors are to be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels are to be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary functions will be permitted in fire alarm raceways.

E. Conductors in cabinets must be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals must be numbered and coded.

F. Wiring splices are to be avoided to the extent possible, and, if need, they must be made only in junction boxes which are to be painted fire-alarm red.

G. Color codes must be used throughout. Transposing or changing color coding of wire will not be permitted. Wire nut-type connections are not acceptable. All conductors in conduit pull boxes or cabinets containing more than one wire must be labeled on each end with “E-Z Markers” or equivalent.

H. Provide all necessary emergency power to the complete Fire Alarm System in accordance with the manufacturer’s requirements.

3.3 PAINTING

A. Paint exposed electrical, fire alarm conduit and surface metal raceway to match adjacent finishes in exposed areas. Paint conduit and surface metal raceways red in unfinished areas and above finished ceilings.

3.4 FIELD QUALITY CONTROL

A. Preliminary Tests

1. Conduct the following tests during installation of wiring and system components. Correct any deficiencies pertaining to these requirements prior to formal functional and operational tests of the system.
2. Ground Resistance

    a. Measure the resistance of each connection to ground. Ground resistance shall not exceed 10 ohms.

3. Dielectric Strength and Insulation Resistance

    a. Test dielectric strength and the insulation resistance of system interconnecting wiring by means of an instrument capable of generating 500-Volts D.C. and

equipped to indicate leakage current in 1000 mega-ohms. For the purpose of this test, instrument shall be connected between each conductor on the line and between each conductor and ground at control panel and of line, with the other extremity open circuited and series-connected devices shunted or in place. System shall withstand test without breakdown and indicate a resistance of not less than 500,000 ohms, the measurement being taken after an electrification of not more than 1.0 minute with a dc potential of not less than 100-Volts nor more than 550-Volts. Dielectric tests shall be witnessed by Engineer or their designee.

4. Smoke and Thermal Sensor Tests

    a. Prior to formal inspection and tests, clean and perform sensitivity tests on each smoke and thermal sensor. Clean the smoke and thermal sensors in accordance with the manufacturer's recommended procedures. Perform voltage activation sensitivity test on each sensor and record the results. Remove sensors with a sensitivity level above or below the UL accepted sensitivity range for that sensor and replace with new sensors. Present recorded data at the formal inspection for verification. Approved copies shall become part of the operations and maintenance manual for the fire alarm system.

5. Field Inspection and Test

    a. Before final acceptance of the work, test each system to demonstrate compliance with the contract requirement. Each system shall be subjected, at minimum, to complete functional and operational tests including tests in place of each smoke sensor and detector, each thermal sensor, each manual station and visual and audio/visual device, tests of wiring supervision and tests of control panel functions.

6. Formal Inspection and Test

    a. The Authority Having Jurisdiction will witness formal tests after receipt of written certification that preliminary tests have been completed and that the system is ready for final inspection. The system manufacturer's technical representative shall be present for the inspection and test. At minimum, preliminary tests shall be repeated and functional and operation tests conducted, as requested by the Architect/Engineer. Correct defects and conduct additional tests to demonstrate that the system conforms to contract specifications. Contractor shall provide two-way radios, personnel and test equipment required for conducting tests. Smoke detectors shall be tested using the manufacturer's calibrated test method. In addition, formal testing will require real smoke to be used to test smoke detectors. Canned smoke will not be permitted. Test equipment shall be turned over to the Authority Having Jurisdiction following test completion.

7. Manufacturer's Field Service

    a. Manufacturer's Representative

        1) Furnish the services of a factory-trained fire alarm system manufacturer's representative or technician, experienced in the installation and operation of the type of system being provided, to supervise the installation, testing, including formal testing, adjustment of the system, and instruction to the facility personnel. Furnish names and phone numbers of the factory-trained fire alarm system representatives or technicians.

B. Training

1. Equipment manufacturer shall provide 2 hours on site technical training to the owner or its representative (for two persons designated by Owner). Training shall allow for individual hands on programming, trouble-shooting and diagnostics exercises. Training shall occur within 1 month of system acceptance.

C. Adjustments

1. Equipment manufacturer shall provide necessary subsequent custom reprogramming to modify and adjust operations and individual identification nomenclature to the owner satisfaction four months after final system acceptance and twelve months after system acceptance. Reprogramming is to be done at the job site and witnessed by the Authority Having Jurisdiction representative. Revision of as-built and record drawings shall be by the installing Contractor.

END OF SECTION 28 46 00

SECTION 312000 - EARTH MOVING

1.1 SUMMARY

A. Rough grading the Site.

B. Preparing subgrades for slabs-on-grade and plants.

C. Drainage course for concrete slabs-on-grade.

D. Subsurface drainage backfill for walls and trenches.

1.2 MATERIALS

A. Soil Materials: Satisfactory and unsatisfactory soil classifications, subbase material, base course engineered fill, bedding course drainage course, filter material, sand.

B. Geotextiles: Subsurface drainage geotextile and separation geotextile.

C. Controlled Low-Strength Material: Conventional weight concrete.

D. Warning Tape: Polyethylene film or Detectable, polyethylene film where underground utilities are present.

1.3 EXCAVATION

A. Hand-excavate in tree- and plant-protection zones.

B. Disposal of Surplus and Waste Materials: Satisfactory soil to designated storage areas on Owner's property; waste materials and unsatisfactory soil off Owner's property.

1.4 FIELD QUALITY CONTROL

A. Special Inspector and Testing Agency: Owner engaged.

END OF SECTION 312000

SECTION 323113 - CHAIN LINK FENCES AND GATES

1.1 QUALITY ASSURANCE

A. Mockups of fences and gates.

1.2 WARRANTY

A. Materials and Workmanship: per manufacturer specifications.

1.3 PERFORMANCE REQUIREMENTS

A. Engineering design of chain-link fence and gate frameworks by Contractor.

B. Structural Performance: ASCE/SEI 7.

1. Minimum Post Size and Maximum Spacing: CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms.

1.4 CHAIN-LINK FENCES AND GATES

A. Fence Fabric: Steel wire mesh sized 2 inches.

B. Fence Framework: Steel.

1. Fence Height: 60 inches.
2. Posts and Rails: Heavy industrial strength.
3. Rail Members: top, bottom and brace rails.
4. Finish: Galvanized coating.

C. Gates:

1. Swing Gates: Steel framework.
2. Finish: Matching fence framework.

D. Privacy Slats: Fiber-glass-reinforced plastic.

1.5 INSTALLATION

A. Chain-Link Fencing: ASTM F567.

B. Post Setting: In concrete.

C. Grounding and Lightning Protection: NFPA 780 and Section 260526 "Grounding and Bonding for Electrical Systems."

1.6 FIELD QUALITY CONTROL

A. Grounding Testing: By Contractor.

END OF SECTION 323113

SECTION 329300 - PLANTS

1.1 QUALITY ASSURANCE

A. Installer's Personnel Certifications: Landscape Industry Certified Technician – Exterior.

1.2 WARRANTY

A. Ground Covers: 12 months.

1.3 MATERIALS

A. Mulches: Shredded hardwood.

B. Weed-control barrier.

C. Pesticides.

1.4 INSTALLATION

A. Pruning: Minimal.

B. Ground Cover Planting: Space ground covers: 12 inches apart.

C. Mulching:

1. Planting Areas: 3-inch thickness of organic mulch over whole surface of planting area.

1.5 MAINTENANCE SERVICE

A. Ground Cover and Other Plants: 12 months.

END OF SECTION 329300